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A Revision of the *Yoyetta abdominalis* (Distant) Species Group  
of Cicadas (Hemiptera: Cicadidae: Cicadettinae),  
Introducing Eight New Species

*by*

David L. Emery, Nathan J. Emery, and Lindsay W. Popple

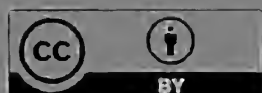


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*Cover image*—Chalcids are cooperative. Mating period summer. The larger species are well known; males sing at rest and females fly to them and mate. In contrast, many of the medium-sized chalcids like those in the *Mesochorus* are less well known. They produce less sound and males simply tick as they fly among trees and shrubs, always alert to the wing-tick signals of females. Species of *Praon* differ more by song than by superficial morphology. Comparative studies reported here have not used (in both sounds and microscopic morphology) and the genus is discovered to be far more complex than originally appreciated. The *Y. danusoides* *melanocephalus* (the *Praon*) contain more than 15 species distinguished by black and orange-red coloration set off by flashes of white over the hindwing plaques.

The Australian Museum houses some of the world's most important collections of Australian animal, fossil and geological specimens and cultural objects. Research on these collections of specimens and artefacts yields insights into how our world changes through time and how its diversity can be classified, interpreted and appreciated. This knowledge, when shared among the scientific and broader communities—initially through publication—helps us understand the significance of the impact we have on our environment. The collections represent key research infrastructure that will have increasingly significant value through the rest of this century and into the future. From this resource, we come to know what reasonable steps society can take now for the well-being of future generations. Our responsibility is also to inspire the exploration of nature and cultures: our vision is a beautiful and sustainable natural world with vibrant and diverse cultures that we are able to see, appreciate and know deeply.

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*Editorial note*—The Australian Museum is pleased to announce that the journal *Records of the Australian Museum* is now available online. The journal is published by the Australian Museum, Sydney, New South Wales, Australia. The journal is published by the Australian Museum, Sydney, New South Wales, Australia.

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# A Revision of the *Yoyetta abdominalis* (Distant) Species Group of Cicadas (Hemiptera: Cicadidae: Cicadettinae), Introducing Eight New Species

DAVID L. EMERY<sup>1</sup> , NATHAN J. EMERY<sup>2</sup>  AND LINDSAY W. POPPLE<sup>3</sup> 

<sup>1</sup> Sydney School of Veterinary Science, University of Sydney NSW 2006, Australia

<sup>2</sup> Australian PlantBank, Royal Botanic Gardens and Domain Trust,  
The Australian Botanic Garden, Mount Annan NSW 2567, Australia

<sup>3</sup> Entomology Section, Queensland Museum, South Brisbane Qld 4101, Australia

**ABSTRACT.** This study provides redescrptions of four medium-sized cicada species within the *Y. abdominalis* (Distant) species group, including *Yoyetta aeede* (Walker), *Y. abdominalis*, *Y. denisoni* (Distant) and *Y. kershawi* Goding & Froggatt stat. rev., comb. nov., from southeastern Australia. Eight new species of *Yoyetta*, belonging to this group are described, from eastern Australia. These are: *Y. electrica* sp. nov., *Y. grandis* sp. nov., *Y. regalis* sp. nov., *Y. serrata* sp. nov., *Y. spectabilis* sp. nov., *Y. subalpina* sp. nov., *Y. timothyi* sp. nov., and *Y. verrens* sp. nov. Sections describing morphological distinguishing features, distribution, habitat and behaviour, and calling songs (where available) are provided for each species with illustrations throughout. Additional locational records for *Y. hunterorum* (Moulds) are presented and its song described.

## Introduction

Cicadas are conspicuous insects of the Australian summer. Of all cicada tribes recognized in Australia, Cicadettini is by far the most diverse, comprising the majority of smaller, thin-bodied species (Moulds, 2012). The genus *Yoyetta* Moulds was erected to accommodate nine Australian species, previously allocated to the genus *Cicadetta* Kolenati. Emery *et al.* (2015) synonymized one of the species and added an additional four. However, examination of available material in entomological collections has revealed this genus to be highly diverse and it may ultimately contain more than 50 cicada species.

Emery *et al.* (2015) also reported three informal species groups within the *Yoyetta* genus. The *Yoyetta abdominalis* species group is readily identified with hind wing plaga almost entirely white and opaque, and abdominal tergites

2–7 mainly black or dark brown. The *Yoyetta incepta* species group present with hind wing plaga opaque and cream to pale orange-brown along the majority of the jugal fold and outer margin, and abdominal tergites mainly black, while in the *Yoyetta tristrigata* species group, the hind wing plaga is opaque and cream to light brown or orange-brown along majority of jugal fold and outer margin, and abdominal tergites 2–7 are mainly orange to yellow-brown. This study focuses on the *Yoyetta abdominalis* species group.

Following Emery *et al.* (2015), the *Yoyetta abdominalis* species group contains four described species, *Yoyetta aeede* (Walker), *Y. abdominalis* (Distant), *Y. denisoni* (Distant) and *Y. hunterorum* (Moulds); all are small- to medium-sized cicadas. *Yoyetta aeede* was described (as *Cicada aeede*) from a single female specimen from Adelaide, South Australia (Walker, 1850). A small number of additional specimens has been found among older accession material

**Keywords:** Australia; behaviour; cicada; Cicadidae; *Yoyetta*; distribution; habitat; taxonomy

**Taxonomic registration:** (LSID publication) <http://zoobank.org/0C138CF3-68E5-4A22-A46E-3DDC57F0FD2E>

**Corresponding author:** David L. Emery [david.emery@sydney.edu.au](mailto:david.emery@sydney.edu.au)

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at the South Australian Museum during the course of this study and, fortuitously, fresh material was obtained during an emergence in late 2018. *Melampsalta kershawi* Goding & Froggatt was also described from a single female from Marysville, Victoria. It was subsequently placed into synonymy with *Y. denisoni* by Ashton (1912). Extensive collection of specimens and song recordings over many years have led to the revelation that both *Y. abdominalis* and *Y. denisoni* represent complexes of several cicada species. Here we refine and redescribe *Y. aeade*, *Y. abdominalis* and *Y. denisoni*, and raise *M. kershawi* from synonymy. Eight new species are described in the *Yoyetta abdominalis* species group. Song data and waveform plots are provided in addition to the standard morphological descriptions for all examples where song recordings are available. Finally, additional locational records for *Y. hunterorum* are presented and its song described.

## Methods and terminology

Anatomical terminology follows Moulds (2005, 2012) for body structures and wing characters, Moulds (2005) for genitalia, and Dugdale (1972) and Bennet-Clark (1997) for timbals. The long timbal ribs are referred to as long ribs 1–5, with long rib 1 being the most posterior (adjacent to timbal plate). The higher classification adopted in this paper follows Moulds (2012). Measurements (in mm) are given as ranges and means (in parentheses) and include the largest and smallest specimens. Head width spans across the eyes; pronotum width across the extremities of the lateral margins; abdomen width is measured across the outer edges of the auditory capsules. Measurements were taken using a pair of Supatool digital calipers or Toledo manual calipers (accurate to 0.1 mm). Localities that are National Parks (NP) or State Forests (SF) are abbreviated. The three authors (DE, NE & LP) are together the authority for each of the new species described.

**Abbreviations.** Material sourced for this taxonomic work is located in collections abbreviated as follows:

AM	Australian Museum, Sydney;
ANIC	Australian National Insect Collection, CSIRO, Canberra;
NHM	Natural History Museum, London, UK;
McM	Macleay Museum, University of Sydney, Sydney;
MMV	Melbourne Museum, Victoria;
QM	Queensland Museum, Brisbane;
UQIC	University of Queensland Insect Collection (now in QM);
SAM	South Australian Museum, Adelaide;
RBINS	Royal Belgian Institute of Natural Sciences, Brussels, Belgium;
TMAG	Tasmanian Museum and Art Gallery, Hobart;
DE	private collection of D. L. Emery, Sydney;
MSM	private collection of M. S. Moulds, Kuranda;
LWP	private collection of L. W. Popple, Brisbane;
FD	private collection of F. Douglas, Rainbow;
JP	private collection of J. Poyitt, Sydney.

**Genitalia preparation.** Male genitalia were removed using a pair of surgical scissors and placed in a solution of 10% potassium hydroxide. The solution was either boiled for one hour or left overnight at room temperature to clear the soft tissues and provide a clean dissection. Following clearing,

the specimens were washed with ethanol and placed into a solution of either 70% ethanol or glycerol. To facilitate close examination of internal structures, the aedeagus was dissected for each genitalia preparation under 10× magnification.

**Imaging.** Photographs were taken using an Olympus stereo dissecting microscope mounted with an SC100 camera. Individual or photostacked images were processed with Cells-sens™ and Adobe Photoshop software.

**Calling song analysis.** The description of calling songs follows Ewart & Marques (2008). A “pulse” was defined as a single whole movement of the timbals. The term “syllable” was used for the smallest grouping of pulses (typically 5–10 ms duration). When multiple syllables occur in succession, without coalescence (i.e. where the syllables are separated by short periods of silence), this was termed a “syllable sequence”. Where 2–9 syllables coalesce, this was referred to as a “macrosyllable”. Longer durations of continuous sound (≥10 syllables) were referred to as an “echeme”. For a repeated unit, comprising more than one of the above terms, the term “phrase” was adopted. Periods of silence between pulses, syllables, macrosyllables, echemes and/or phrases are termed “gaps”. Bouts of calling that are dominated by repeated macrosyllables or echemes were treated broadly as “chirping songs”. Where distinctly different sections of song, containing repeated combinations of pulses, syllables, macrosyllables, echemes and/or phrases are apparent and occupy several seconds duration, each section is referred to as a song “mode”.

Field recordings have been used, but if such recordings were not available, we examined recordings taken in captivity of a container or fabric cage. The former captivity recordings have a greater tendency to show distortion of the finer pulse structures of the songs and amplitude spectra due to reverberation. To address this problem, all recordings were carefully examined prior to analysis to select the cleanest and most natural representations for comparative purposes. A preference was generally given to recordings obtained as close as possible to the type locality. All recordings were taken from a distance of at least 20cm from the calling insect to reduce the chances of near-field effects. None of the recordings displayed signs of amplitude clipping due to microphone overload.

The recording systems (RS) used can be detailed as follows:

- RS1 Sony MZR700 minidisc recorder with Sony ECM-MS957 Electret Condenser microphone (frequency response up to 18 kHz), with recordings taken in the field (unless otherwise noted) by LWP.
- RS2 Tascam DR-07 digital recorder with an Audio-Technica ATR-55 cardioid condenser shotgun microphone (frequency response up to 18 kHz), with recordings taken in the field by LWP.
- RS3 Tascam DR-40 digital recorder with a Sennheiser ME66 shotgun microphone and K6 power source, with recordings taken in the field by LWP.
- RS4 Marantz PMD-660 Solid State Recorder with a Sennheiser K6/ME66 microphone with recordings taken by David Marshall.
- RS5 Tascam DR-07 digital recorder (with in-built microphone), with recordings taken in the field by B. Smith.

RS6 Tascam DR-05 digital recorder (with in-built microphone), with recordings taken in the field by NJE.

Processing and analyses of recordings were undertaken with Cool Edit Pro (Version 2.1) software. Amplitude spectra were analysed in and WaveShop (Version 1.0.14) software using a linear frequency axis on a 1024-point Fast Fourier Transform with a Hamming window function.

### Infrageneric relationships within *Yoyetta*

The infrageneric groupings within *Yoyetta* follow Emery *et al.* (2015). Accordingly, the *Yoyetta abdominalis* species group is defined by the following characters: (1) hind wing plaga almost entirely opaque and mainly white, and (2) abdominal tergites 2–7 mainly black or dark brown. A list of species included in this group is provided below.

### *Yoyetta abdominalis* species group

*Yoyetta aaede* (Walker)  
*Yoyetta abdominalis* (Distant)  
*Yoyetta denisoni* (Distant)  
*Yoyetta electrica* sp. nov.  
*Yoyetta grandis* sp. nov.  
*Yoyetta hunterorum* (Moulds)  
*Yoyetta kershawi* (Goding & Froggatt) stat.rev., comb.nov.  
*Yoyetta regalis* sp. nov.  
*Yoyetta serrata* sp. nov.  
*Yoyetta spectabilis* sp. nov.  
*Yoyetta subalpina* sp. nov.  
*Yoyetta timothyi* sp. nov.  
*Yoyetta verrens* sp. nov.

### Keys to species in the *Yoyetta abdominalis* species group

Specimens must be set with wings spread to begin using these keys. For males, in some cases, the genitalia will need to be exposed (or dissected) to allow examination of the aedeagus. A vernier caliper is required to check measurements. Male specimens must often be examined microscopically and may require dissection in some instances.

#### Key to males

- |   |                                                                                                                                                                                      |                       |
|---|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|
| 1 | Abdominal tergites 2–8 and sternites II–VII uniformly black or brown without orange- or yellow-brown markings; inter-segmental membranes dark and inconspicuous .....                | 2                     |
| — | Abdominal tergites 2–8 mainly black with contrasting orange- or yellow-brown markings, or contrasting intersegmental membranes; sternites II–VII mainly yellow-brown or orange ..... | 4                     |
| 2 | Fore wing basal membranes orange or pale orange-white .....                                                                                                                          | <i>Y. timothyi</i>    |
| — | Fore wing basal membranes red .....                                                                                                                                                  | 3                     |
| 3 | When viewed from ventral side, tip of aedeagus strongly bifurcate, with apical arms splayed laterally, sometimes in a weak “v” shape, at an angle of 150–180 degrees .....           | <i>Y. denisoni</i>    |
| — | When viewed from ventral side, tip of aedeagus undivided or weakly divided, without distinct lateral arms .....                                                                      | <i>Y. kershawi</i>    |
| 4 | Tergites 5–7 partly black with contrasting, orange or yellow markings .....                                                                                                          | 5                     |
| — | Tergites 5–7 entirely dark brown to black with yellow or orange coloration restricted to the intersegmental membranes .....                                                          | 9                     |
| 5 | Opercula mainly pale grey to dark grey-brown .....                                                                                                                                   | 6                     |
| — | Opercula mainly red or orange .....                                                                                                                                                  | 8                     |
| 6 | Dorsal surface of head, pronotum and mesonotum typically covered with dense gold pubescence; fore wing basal membranes orange or pink .....                                          | <i>Y. abdominalis</i> |
| — | Head, pronotum and mesonotum not covered in conspicuous pubescence; fore wing basal membranes pale grey .....                                                                        | 7                     |
| 7 | Lateral sides of tergites 3–7 mainly orange; tergite 8 with orange markings on anterodorsal side .....                                                                               | <i>Y. aaede</i>       |
| — | Lateral sides of tergites 3–7 mainly black (with yellow dorsolateral markings); anterodorsal side of tergite 8 black .....                                                           | <i>Y. serrata</i>     |

- 8 Body length < 23 mm; sternites III–VII bright reddish-orange without a continuous dark brown to black central marking ..... *Y. spectabilis*
- Body length > 23 mm; sternites II–VII yellowish-orange or reddish-brown with a continuous dark brown to black central marking ..... *Y. regalis*
- 9 Fore wing length < 26 mm ..... 10
- Fore wing length > 26 mm ..... 11
- 10 Pronotum dark brown to black with contrasting yellow-brown central marking ..... *Y. electrica*
- Pronotum dark brown to black without contrasting yellow-brown central marking ..... *Y. hunterorum*
- 11 Dorsal surface of head, pronotum and mesonotum with an inconspicuous, sparse covering of pubescence; sternite 8 mainly black ..... *Y. grandis*
- Dorsal surface of head, pronotum and mesonotum typically with dense, black pubescence ..... 12
- 12 Opercula mainly brown, dark brown or dark reddish-brown; intersegmental membranes yellow ..... *Y. subalpina*
- Opercula mainly dull red, pale red or reddish-brown ..... 13
- 13 Hind wing plagas opaque with bold white colouration that extends to cover the entire jugum; Apex of theca distinctly club-shaped; transparent flange along margin of recurvature not quite as broad as thecal shaft ..... *Y. regalis*
- Hind wing plagas partly hyaline with dull white colouration restricted to basal margins of anal cell 3 and vein 2A. Apex of theca not club-shaped but narrow with spine-like dorsal and ventral ornamentation; transparent flange along margin of recurvature much broader than thecal shaft ..... *Y. verrens*

### Key to females

- 1 Ovipositor sheath extends < 1 mm beyond apex of abdominal segment 9 ..... 2
- Ovipositor sheath extends > 1 mm beyond apex of abdominal segment 9 ..... 9
- 2 Pronotum mainly black or dark brown with a contrasting yellow-brown central marking ..... 3
- Pronotum mainly black or brown without central marking inconspicuous or similar in colour to other parts of pronotum ..... 6
- 3 Head width < 6 mm ..... *Y. electrica*
- Head width > 6 mm ..... 4
- 4 Dorsal surface of head, pronotum and mesonotum typically covered with dense gold pubescence; tergite 8 with distinct orange lateral marking that is similar in shape to yellow markings on tergites 5–7 ..... *Y. abdominalis*
- Dorsal surface of head, pronotum and mesonotum typically with sparse, black pubescence or without conspicuous pubescence; tergite 8 mainly black, without a marking that is similar in shape to the yellow markings on tergites 5–7 ..... 5
- 5 Tergites 6 and 7 black with distinctive, yellow triangular markings on dorsolateral sides, widening towards posterior margins ..... *Y. serrata*
- Tergites 6 and 7 orange anteriorly with broad black bands extending to posterior margins ..... *Y. aede*

- 6 Tergites 5–7 black with distinctive, yellow triangular markings on dorsolateral sides, widening towards posterior margins ..... *Y. spectabilis*
- Tergites 5–7 mainly brown to reddish-brown, or black ..... 7
- 7 Fore wing basal membranes red or pink ..... *Y. denisoni* or *Y. kershawi*
- Fore wing basal membranes pale orange-white or orange ..... 8
- 8 Tergites 3–8 brown, a combination of brown (or reddish-brown) and black or entirely black ..... *Y. timothyi*
- Tergites 3–8 black with orange coloration on dorsolateral posterior margins, with the orange most conspicuous on tergite 6 ..... *Y. subalpina*
- 9 Ovipositor sheath extends  $\geq 2$  mm beyond apex of abdominal segment 9 ..... 10
- Ovipositor sheath extends  $< 2$  mm beyond apex of abdominal segment 9 ..... 11
- 10 Hind wing plagas opaque with bold white colouration that extends to cover almost the entire jugum; found south of 32°S ..... *Y. hunterorum*
- Hind wing plagas partly hyaline with dull white colouration restricted to basal margins of anal cell 3 and vein 2A); found north of 32°S ..... *Y. verrens*
- 11 Fore wings distinctly angulated at costal nodes; costal veins mainly reddish-brown or orange-brown; dorsolateral sides of tergites mainly reddish-brown ..... *Y. regalis*
- Fore wings gradually curved at node; costal veins mainly dark brown; dorsolateral sides of tergites mainly dull brown to black ..... *Y. grandis*

## Systematics

### Family Cicadidae Latrille, 1802

### Subfamily Cicadettinae Buckton, 1889

### Tribe Cicadettini Buckton, 1889

### Genus *Yoyetta* Moulds, 2012

**Diagnosis.** Diagnosis follows Moulds (2012) with modifications of Emery *et al.* (2015).

**Type species.** *Cicadetta celis* Moulds, 1988.

### *Yoyetta denisoni* (Distant, 1893)

Figs 1, 2B, 3B, 4–6, 10A, 52B, 53A

*Melampsalta denisoni* Distant, 1893: 78, plate VII, figs 14, 14a, 14b (female); Goding & Froggatt, 1904: 636, plate xviii, figs 7, 7a; Distant, 1906: 174; Ashton, 1912: 24; Ashton, 1914: 354; Greenup, 1964: 23.

*Cicadetta denisoni*.—Moulds, 1990: 156–157, plate 17, figs 8, 8a, plate 24, fig. 14; Naumann, 1993: 22, 80, 149; Moss & Popple, 2000: 57; Moulds & Cowan, 2002: 26; Williams, 2002: 15; Arensberger *et al.*, 2004: 558, 566; Emery *et al.*, 2005: 109.

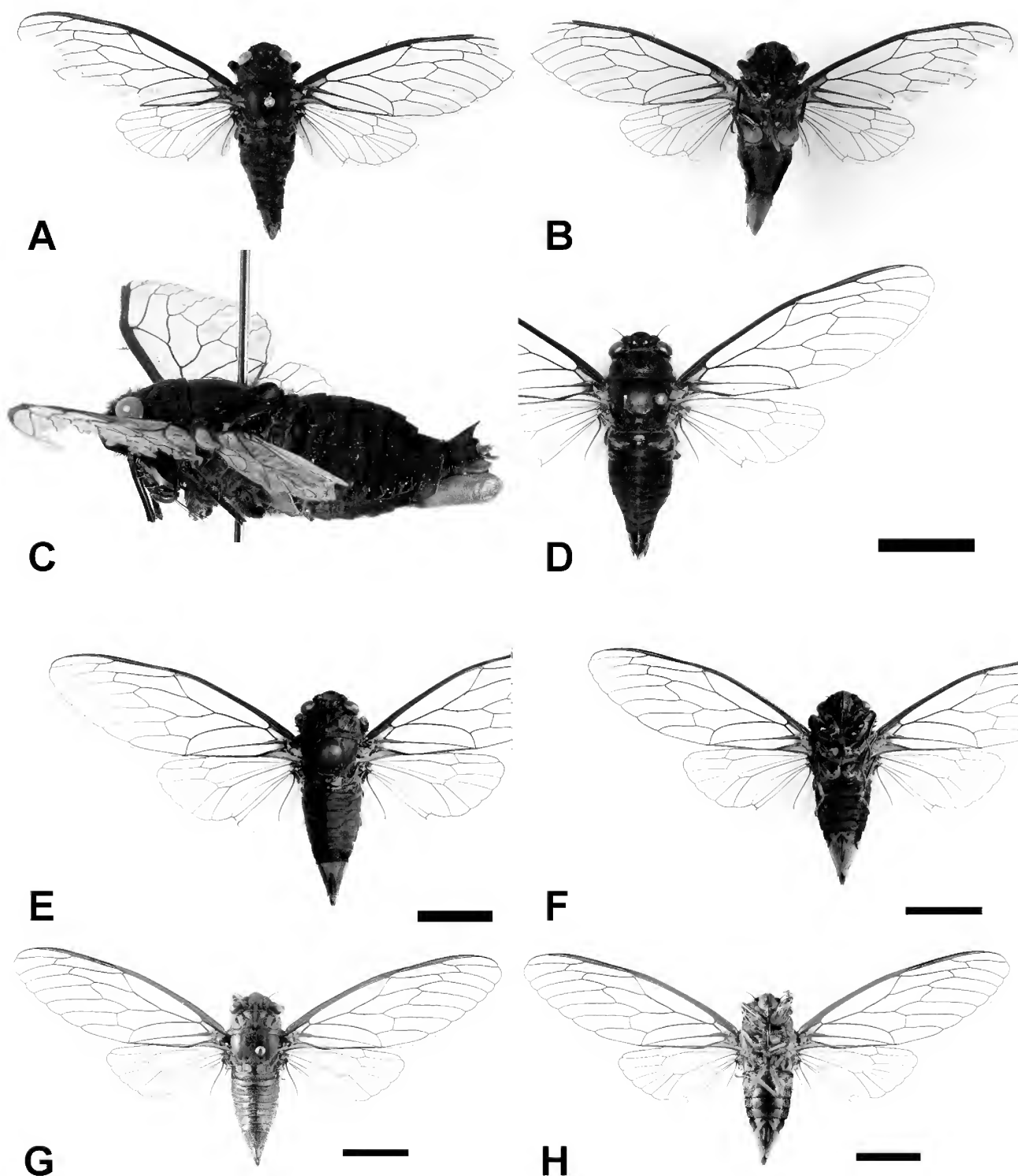
Not *Cicadetta denisoni*.—Ewart, 1986: 51–52, table 1.

*Yoyetta denisoni* (Distant, 1893).—Moulds, 2012: 24, 237; Sanborn, 2014: 554.

The original description of *Y. denisoni* (Distant, 1893) refers to a male specimen and is based on material “contained in

the Brussels Museum”. Therefore, this specimen must be treated as the holotype (below). There are also specimens of both sexes from the same locality in the NHM (listed below) with red “type” labels. However, as noted by Moulds (1990), the type locality (Port Denison near Bowen in Queensland, Australia) must be regarded as erroneous.

**Material examined.** Holotype male, [handwritten] “*Melampsalta denisoni* Dist.” / [typeset] “Coll. R. I. Sc. N. B., Australie”, “Coll. Camille van Voixem”, [handwritten] “Port Denison, W. 68” / [typeset] “Type” / “Holotype” (RBINS). 1♂ 1♀, same location and collection data as holotype [locality erroneous] (NHM). NEW SOUTH WALES: 1♂, Batemans Bay, 1.ii.20, ANIC database no. 20 010775; 1♂, New South Wales, Kioloa Creek crossing, 2.5 km W. on Dangerboard Road, temperate rainforest, 35°32'51"S 150°20'54"E, 27.i.2014, D. J. & R. L. Ferguson; (ANIC); 1♂ 1♀, Tumbarumba, NSW, 35°51'54"S 148°06'54"E, 750m, 31.xii.13, A. Kwok, S. Travers; 2♂♂, Mt. Gibraltar, Bowral, NSW, 34°27'44"S 150°25'40"E, 800 m, 23.xii.13, N. & D. Emery; 1♀, same location, 10.xii.2017, L. Nolan (DE); 2♂♂, NSW Dampier SF Diamond Ck Survey Tk. 0.5 km N of Junctn with Little Sugarloaf Rd (Deua National Park), 17.xii.1991, F. Douglas (AM K.264315, AM K.307123); 1♀, Wagga, 2.xii.1965, S. Hamlyn (UQIC); 4♂♂, Lemann Compound, ca 10 km SE of Bowral, NSW, 34°32.50'S 150°29.20'E, 24.xii.1996, C. Lemann & S. McEvey, 12892, 12895–97; 1♀, Jenolan SF, 29.xii.1968, C. E. Chiswick; 1♂ 1♀, 17 miles from Cooma, on Bungarby Road, *Euc. dives*, 9.xii.1961, L. R. G[reenup] (MSM). AUSTRALIAN CAPITAL TERRITORY: 1♂, 1♀, Tidbinbilla Nature Reserve, ACT, 9.iii.1978, P. Omay (AM); 1♂ 1♀, Black Mtn, Canberra ACT, 15.xii.1964, L. J. Chinnielz, ANIC database nos 20 010698, 20 010701; 1♂, 35°17'S 149°06'E, Black Mt, ACT, 16.i.1987, D. C. F. Rentz, ANIC Database No. 20 010697; 1♂, Bl[ack] Mt, 26.xii.71, E. Maldor, H.-M., K.-O., ANIC database no. 20 10694 (ANIC); 1♂, Frith St, Acton, 35°15'58"S 149°06'34"E, 22.xi.2010, L. W. Popple, D. Emery, 510-0005; 1♂, same data as previous, 24.xi.2010, L. W. Popple 1♂, same data as previous, 6.xii.2010, Emerging, 510-0006; 3♂♂, same data as previous, 2.xii.2016, netted, 510-0012, 510-0014, 510-0015; 1♀, Frith St, Acton, 35°15'58"S 149°06'34"E, 24.xi.2010, 509-0010; 1♂ 1♀, same data, 6.xii.2010, 510-0006, 509-0011 (LWP); 2♂♂, same data as previous, 510-0013, 510-0016 (QM); 1♂, Frith Rd, O'Connor, ACT, 35°16'07"S 149°06'32"E, 24.xi.2009, D. Emery & L. Popple (DE); 1♂, Aranda, 8.xii.2002, Allan Robertson; 1♀, Mt Majura, 27.xi.1977, G. Daniels (MSM).



**Figure 1.** *Yoyetta denisoni* (Distant) (A), holotype male, Port Denison [locality considered to be erroneous], dorsal habitus; (B) holotype male, ventral habitus; (C), holotype male, lateral aspect; (D) male, O'Connor (35°16'S 145°06'E), dorsal habitus; (E), female, Bowral, NSW, 34°27'S 150°25'E, dorsal habitus; (F), female, ventral habitus; (G), female, brown form, dorsal habitus, O'Connor; (H), female, brown form, ventral habitus. Scale bars = 10 mm.

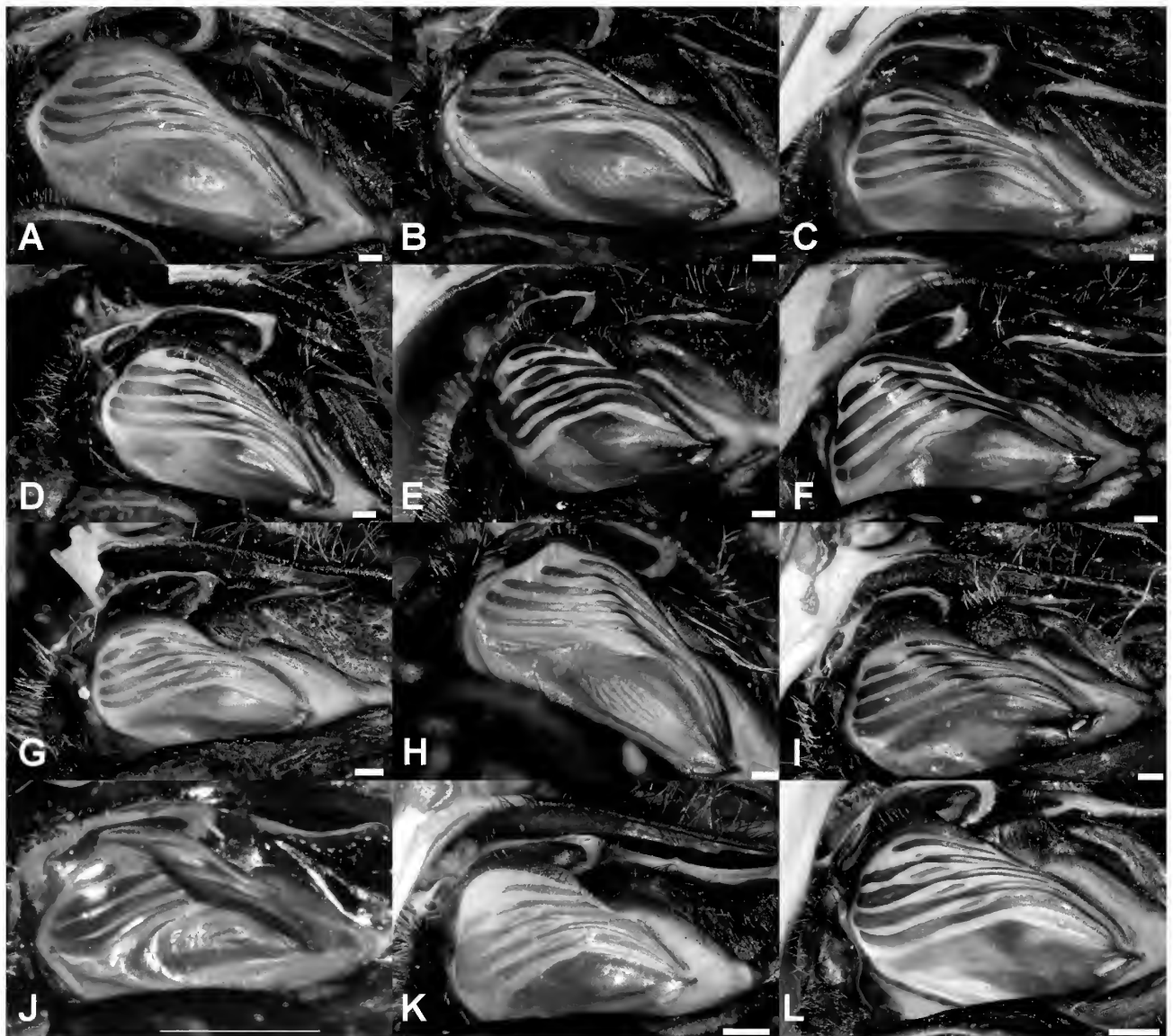
**Additional published records.** NEW SOUTH WALES: Raspberry Lookout, Gibraltar Range, 29°33'S 152°15'E (Moss and Popple, 2000).

**Additional locations with audio recordings.** NEW SOUTH WALES: Forest Track, Royal National Park, NSW, 34°09'04"S 151°01'24"E, 25.xi.2012, B. Smith; Girrakool Picnic Area, Brisbane Waters National Park, NSW, 33°25'54"S 150°16'35"E, 16.xii.2012, B. Smith; Old Grafton Rd, Glen Elgin,

NSW, 29°39'20"S 152°02'38"E, 7.i.2016, L. W. Popple; Jindabyne district, NSW, 36°31'58"S 148°41'36"E, 30.xii.2009, L. W. Popple.

**Distribution, habitat and seasonality.** *Yoyetta denisoni* is found along the ranges and subcoastal forested areas of New South Wales from Gibraltar Range to the south coast





**Figure 2.** Photos of male left timbals, with dorsal edge at left and posterior margin at bottom: (A) *Yoyetta timothyi* sp. nov., Gordon (33°76'S 152°15'E); (B) *Y. denisoni* (Distant), O'Connor (35°16'S 145°06'E); (C) *Y. regalis* sp. nov., Blackheath (33°35'S 150°50'E); (D) *Y. spectabilis* sp. nov., Barren Grounds (34°41'S 150°44'E); (E) *Y. subalpina* sp. nov., Cooma (36°20'S 148°14'E); (F) *Y. verrens* sp. nov., Torrington (25°15'S 153°11'E); (G) *Y. abdominalis* (Distant), Hobart (42°52'S 147°19'E); (H) *Y. kershawi* (Goding & Froggatt) stat. rev., comb. nov., Toolangi, (37°32'S 145°28'E); (I) *Y. serrata* sp. nov., Nimmitabel (36°31'S 149°14'E); (J) *Y. aaede* (Walker), Mt Lofty (34°59'S 138°43'E); (K) *Y. electrica* sp. nov., Arrawarra (30°02'S 153° 11'E); (L) *Y. grandis* sp. nov., Forrest (38°31'S 143°43'E). Scale bars = 200  $\mu$ m; J= 500  $\mu$ m.

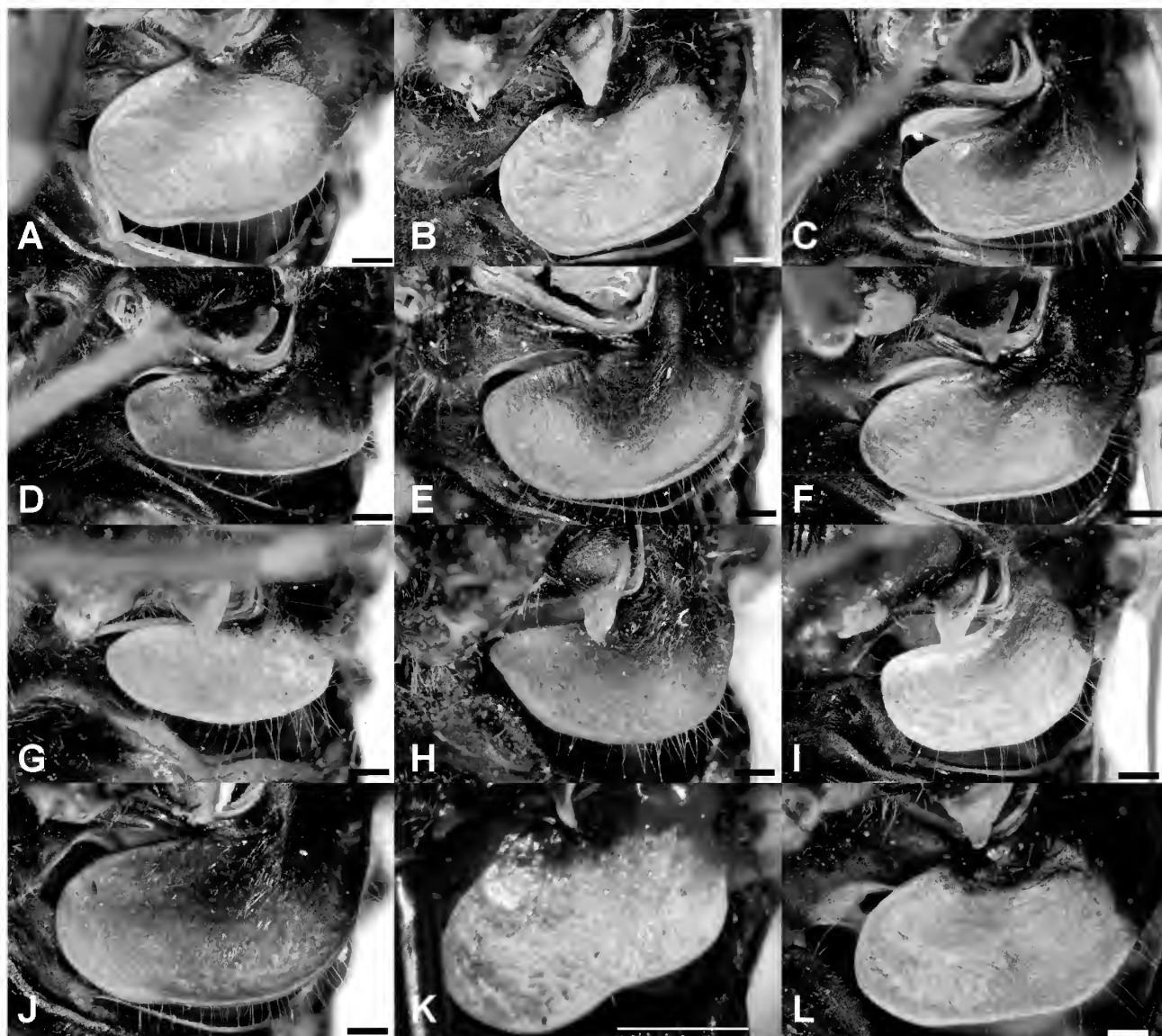
and inland to the Southern Tablelands (Fig. 5). Populations also occur prominently in the Australian Capital Territory and adjacent ranges (Fig. 5). Adults are active in the upper canopy of eucalypt forest and are difficult to attract or capture. They are present from November to January. There is also a single record from as late as March, although this is considered anomalous.

### Description

**Male** (Figs 1A–D, 2B, 3B, 52B). *Head* approximately as wide as mesonotum; predominantly dull black, with a brown to orange-brown central marking on posterior dorsal area extending between lateral ocelli and through dorsal postclypeus; ocelli pink to red; postclypeus predominantly

black, with circular dull reddish-brown markings above either side of central orange line, black transverse grooves below with orange-brown lateral and posterior margins, rounded laterally; lora black; gena black; anteclypeus black; rostrum black anteriorly, variably ochraceous centrally, black at apex, extending to posterior margin of middle coxae; eyes brown to dull black; antennae black, supra-antennal plates black.

*Thorax* almost entirely black; pronotum predominantly black, paramedian and lateral fissures black with intermediate ridges variably dull orange-brown laterally; pronotal collar black, sometimes with central lateral section ochraceous posteriorly. Mesonotum black, cruciform elevation arms black lateral depression orange-brown; scutal depressions black; parapsidal sutures black; metanotum black.



**Figure 3.** Photos of male left opercula, with dorsal edge at left and posterior margin at bottom: (A) *Yoyetta timothyi* sp. nov., Gordon (33°76'S 152°15'E); (B) *Y. denisoni* (Distant), O'Connor (35°16'S 145°06'E); (C) *Y. regalis* sp. nov., Blackheath (33°35'S 150°50'E); (D) *Y. spectabilis* sp. nov., Barren Ground (34°41'S 150°44'E); (E) *Y. subalpina* sp. nov., Cooma (36°20'S 148°14'E); (F) *Y. verrens* sp. nov., Torrington (29°15'S 151°42'E); (G) *Y. abdominalis* (Distant), Hobart (42°52'S 147°19'E); (H) *Y. serrata* sp. nov., Nimmitabel (36°31'S 149°14'E); (I) *Y. electrica* sp. nov., Ararwarra (30°2'S 153°11'E); (J) *Y. grandis* sp. nov., Forrest (38°31'S 143°43'E); (K) *Y. aaede* (Walker), Mt Lofty (34°59'S 138°43'E); (L) *Y. kershawi* (Goding & Froggatt) stat. rev., comb. nov., Toolangi, (37°32'S 145°28'E). Scale bars: A–J =200 µm; K=500 µm.

**Legs** with coxae black; coxal joints bright orange-red; meracantha small creamy, pointed, black at base, partly overlapping opercula; trochanters orange-red; meron reddish; fore femora striped black and red; mid and hind femora with lateral and anterior surfaces black, inner side ochraceous to dark brown; femoral joints orange to pale yellow; tibiae black to dark brown laterally becoming ochraceous medially and towards base, with fore tibial spines black, mid and hind tibial spines variably pale brown and black at tips; tarsal joints orange; tarsi dark brown, becoming black towards claws; claws brown, black at tips.

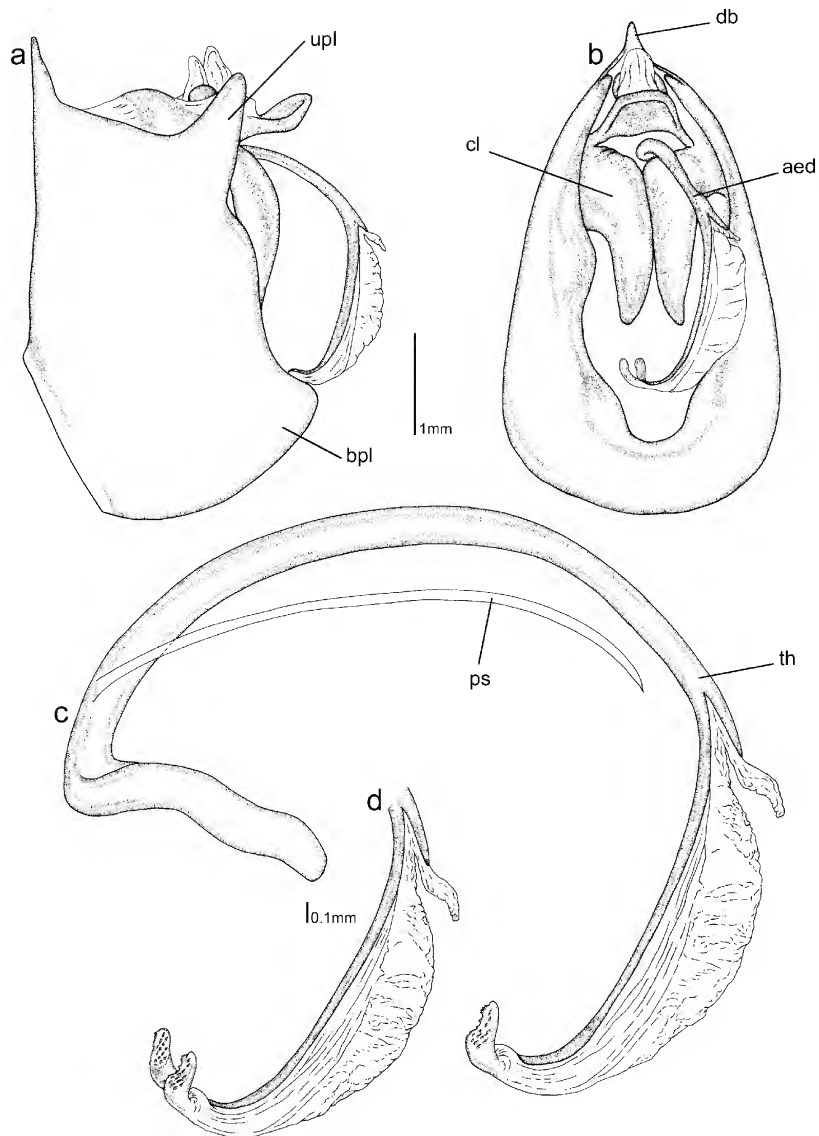
**Wings** with fore wing costal veins black; pterostigma with reddish-brown mottling; basal membranes red to orange; basal cell translucent brown; veins mainly black to dark brown, with eight apical cells; hind wing plaga white,

extending over medial third of anal lobe, remainder of anal lobe diffuse white, veins mainly brown, CuA black proximally, brown after junction, with six apical cells.

**Opercula** (Fig. 3B) medium, spatulate, following body axis ventrolaterally; black at bases, red over remainder, including crests; clearly separated.

**Timbals** (Fig. 2B) with five distinct long ribs, long ribs 1–4 each spanning across timbal membrane and fused dorsally along basal spur; long rib 4 narrowing over third quarter; long rib 5 noticeably shorter than other long ribs; large ridged dome on posterior timbal plate extending across two-thirds of timbal; apodeme pit oval-shaped and conspicuous.

**Abdomen** with tergites 1–8 black. Epipleurites black. Sternite II black, partly ochraceous around inner surface



**Figure 4.** *Yoyetta denisoni* (Distant): illustration of male pygofer and internal genitalia; (a) viewed laterally from the left; (b) viewed ventrally; (c) aedeagus; and (d) apex of theca. Characters include: *aed*, aedeagus; *bpl*, basal lobe of pygofer; *cl*, clasper; *db*, dorsal beak; *ps*, pseudoparameres; *th*, theca; *upl*, upper lobe of pygofer. Specimen from O'Connor (35°16'S 145°06'E).

of tympanal cavity; sternite II black with small central ochraceous marking; sternites III–VII black; sternite VIII black on anterior margin, red over remainder, with black to pale brown pubescence (Fig. 52B).

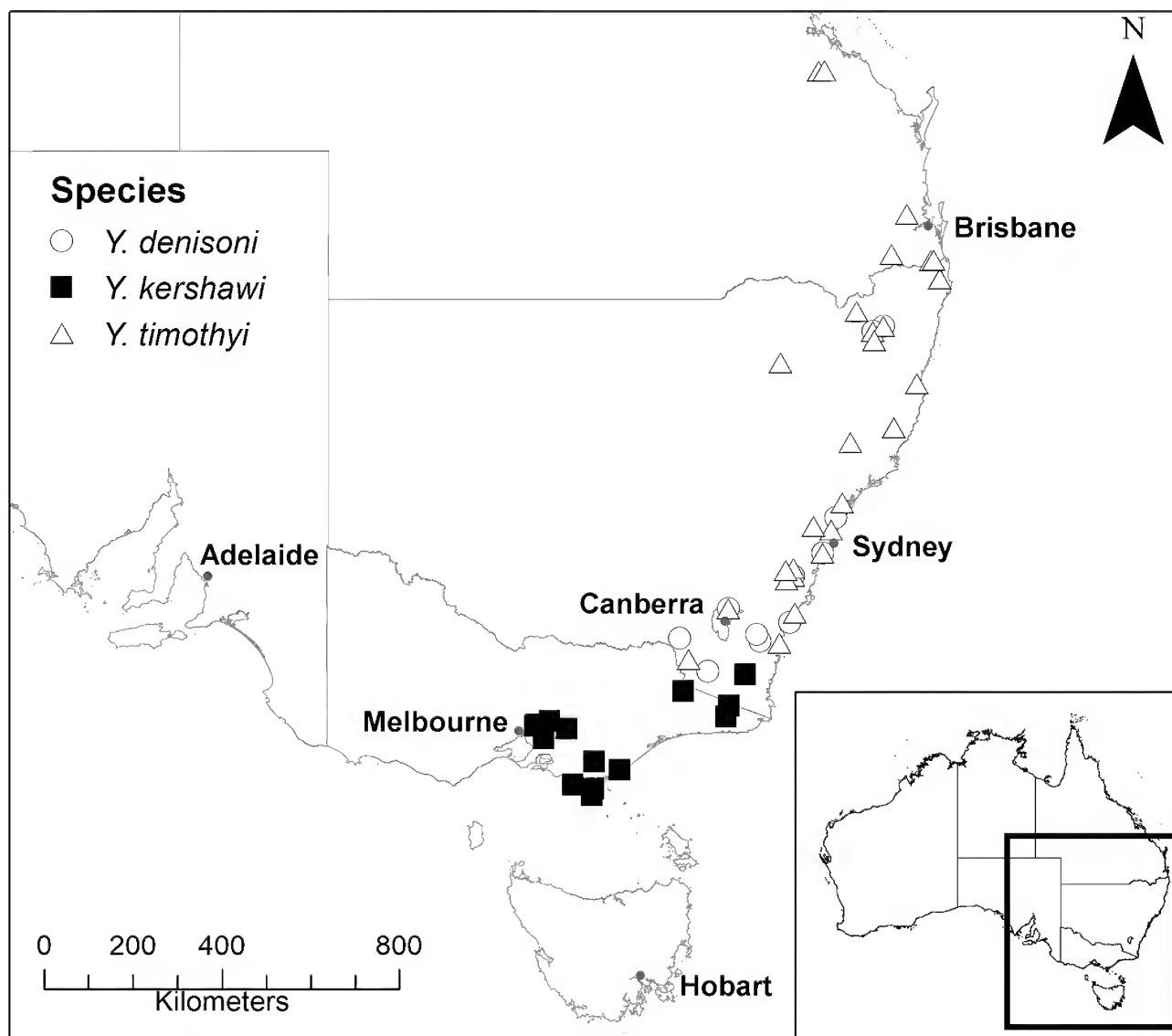
**Genitalia** (Figs 4, 10A). Pygofer mainly black; dorsal beak black, upper lobe prominent, pointed, red at tip; basal lobe dark brown to black; anal styles red. Uncus orange-red, in lateral view beak-like and stumpy; lobes in ventral view less produced, rounded laterally; claspers divided, closely applied, with apices gradually tapering laterally. Aedeagus with pseudoparameres extending around half the length of theca; theca gradually recurved ventrally at 180° towards apex, with translucent flanges along outer margin of recurvature, these smooth dorsally, > 2× diameter of theca, tapering towards apex of theca; apex transparent, sclerotized, bifurcate, each branch directed laterally and dorsally around 90°, with multiple small cornuti on outer edge of each branch.

**Female** (Fig. 1E–G). *Head* and *thorax* similar to male (except in brown specimens).

*Wings* similar to male. Fore wing basal membranes red to pink.

*Abdomen* with tergites 1–8 black (brown posteriorly in brown specimens). Sternites I–VIII black or mainly black; abdominal segment 9 with symmetrical dorsal triangular markings anteriorly, ochraceous and merging centrally, apices directed posteriorly over anterior third, remaining dorsal surface black dorsal beak black, lateral and ventral surface predominantly fiery red, with lateral black spot; anal styles and ovipositor sheath red; ovipositor dark brown to black, extending up to approximately 0.5 mm beyond dorsal beak.

**Measurements** (in mm; range with mean in parentheses: 17 males, 4 females). Body length: male 23.7–27.6 (25.7); female 25.6–26.9 (26.5). Fore wing length: male 28.9–32.5 (32.2); female 31.0–34.1 (32.0). Forewing width: male 9.6–11.2



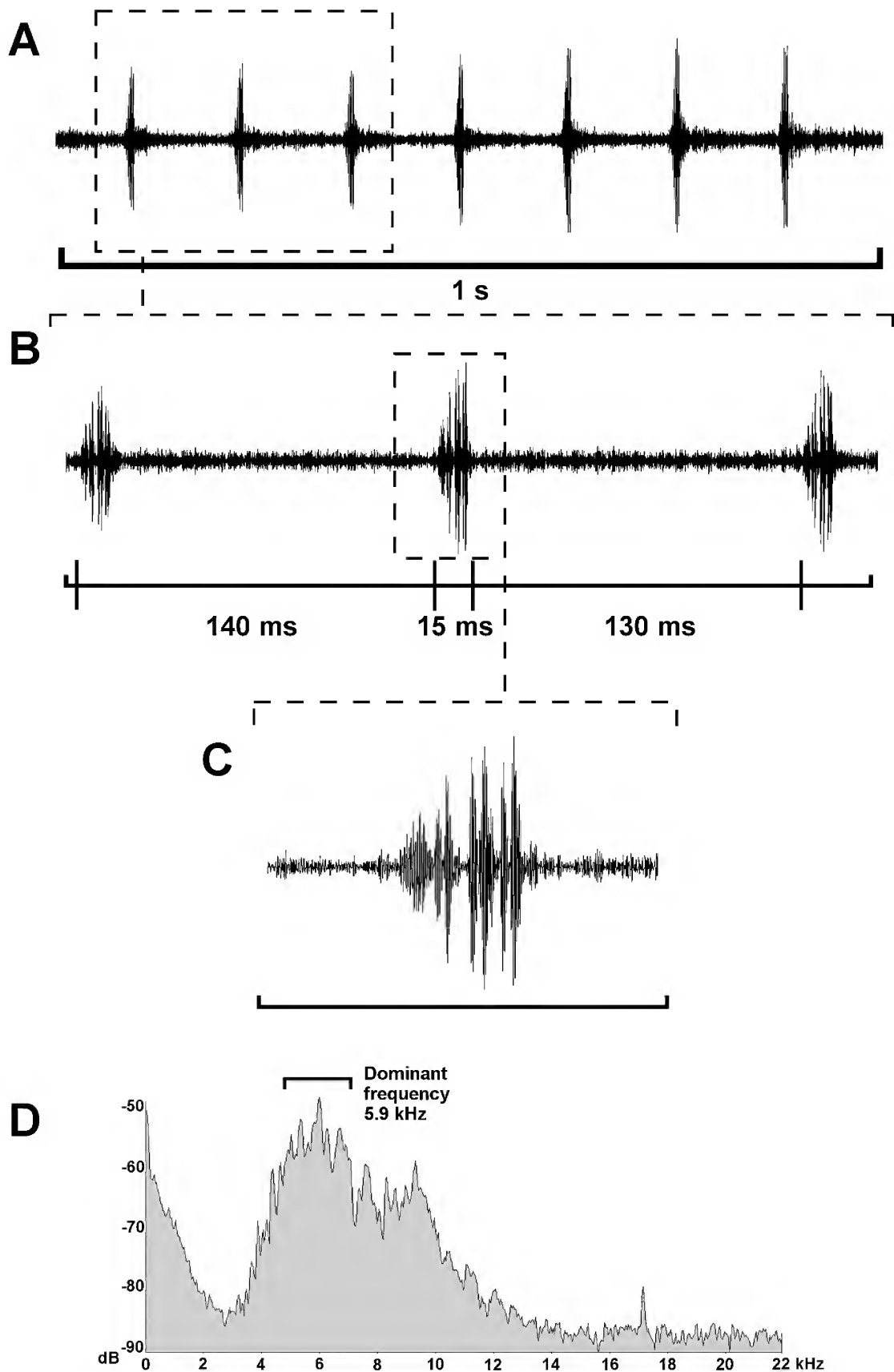
**Figure 5.** Map of southeastern mainland Australia showing the geographical distribution of *Yoyetta denisoni* (Distant) (open circles), *Y. timothyi* sp. nov. (open triangles), *Y. kershawi* (Goding & Froggatt) (closed squares).

(10.6); female 10.9–12.2 (11.3). Head width: male 6.5–7.9 (7.1); female 7.1–7.8 (7.3). Pronotum width: male 7.0–8.2 (7.7); female 8.1–8.4 (8.2). Abdomen width: male 7.2–8.7 (8.0); female 7.3–8.3 (8.0). Ovipositor length: 8.5–8.8 (8.6).

**Colour forms.** Females of *Y. denisoni* are typically black; however a brown form has also been collected in the Canberra region within the Australian Capital Territory. The black form is closely similar to the male, with bright red basal membranes (Fig. 1E,F). It is found throughout the distribution of the species. The brown form is characterized by the predominantly brown colour of the head and thorax (Fig. 1G,H; similar to the brown form of *Y. timothyi* sp. nov., illustrated in Fig. 7C,D). In this form the fore wing basal membranes are red to pink. Only three specimens of the brown form have been collected, two from O'Connor and one from Mt Majura in the Australian Capital Territory. Notably, females of the more typical black form have been collected from Black Mountain, which is adjacent to O'Connor. A single male specimen that may be a brown form has also been collected from Kioloa, New South Wales (in ANIC). It has some brown to dark brown colouration

on the thorax, but is otherwise typical of *Y. denisoni*, with bright red fore wing basal membranes.

**Distinguishing features.** Specimens of *Yoyetta denisoni* can be distinguished morphologically from other species of *Yoyetta*, apart from *Y. timothyi* sp. nov. and *Y. kershawi* stat. rev., comb. nov., by their size (forewing length > 27 mm) and the abdominal tergites, which are uniformly black without orange or yellow markings or contrastingly posterior margins. They can be distinguished from *Y. timothyi* sp. nov. by examining the basal membranes of the fore wings, which are bright red to pink (cf. orange to pale orange-white in *Y. timothyi*). Males can be distinguished from *Y. kershawi* stat. rev., comb. nov. by the presentation of the terminal aedeagus (Fig. 10A), which is strongly bifurcate and splayed into two lateral arms (cf. simple or weakly bifurcate, without lateral arms in *Y. kershawi* stat. rev., comb. nov.; Fig. 10C). Females of *Y. denisoni* are indistinguishable from *Y. kershawi* stat. rev., comb. nov., although the latter species is slightly separated geographically, being restricted to Victoria and adjacent areas in far southeastern New South Wales.



**Figure 6.** Male calling song structure of *Yoyetta denisoni* (Distant) illustrated in waveform plots, including (A) typical rapid chirping song (in flight); (B) expanded section from A showing three macrosyllables; (C) expanded section from B showing detailed structure of a macrosyllable. The final subfigure (D) is a spectrogram displaying song frequency. This specimen was recorded in the field at Canberra (35°16'S 149°07'E) by LWP using RS2 (see *Methods and terminology*).

**Calling song** (Figs 6, 53A). *Yoyetta denisoni* males call when in flight or stationary; however, the call is predominantly made in flight. The call can be described as a rapid chirping song. Each “chirp” is a syllable or short macrosyllable that inflects noticeably in pitch and also to some degree in amplitude within its brief duration. Field recordings are often difficult to obtain as this species mainly calls in flight. Several recordings have been made in Canberra, Royal National Park, Berowra Waters National Park, near Jindabyne and near Glen Innes, all in New South Wales. Based on the recordings ( $n = 9$ ), the (macro)syllable typically ranges from 0.011–0.020 s duration followed by a silent gap of 0.127–0.172 s duration (Figs 6A–C). Field recordings have a frequency plateau of 3.8–8.2 kHz and a dominant frequency from 4.5–6.7 kHz (Fig. 6D).

Of the species with known calling songs, the call of *Y. denisoni* is closest to *Y. timothyi* sp. nov. and *Y. electrica* sp. nov., which each also produce calls in flight, though at a slower rate and faster rate, respectively. Further differences are given under the calling song descriptions of those species.

### *Yoyetta timothyi* sp. nov.

<http://zoobank.org/nomenclaturalActs/27125014-D68E-45B0-93FC-E81CC5895177>

Figs 2A, 3A, 7–9, 10B, 11–12, 52A, 53B

*Cicadetta denisoni*.—Ewart, 1986: 51–52, table 1.

*Cicadetta* nr *denisoni*.—Moss & Popple, 2000: 57; Williams, 2002: 156–157; Emery *et al.*, 2005: 103–107, 109, fig. 5 [left image, male], tables 1C, 2–3; Sanborn, 2012: 554; Ewart, 1986.

Not *Cicadetta* nr *denisoni*.—Emery & Popple, 2005: fig. 5 [right image, female = *Yoyetta hunterorum*].

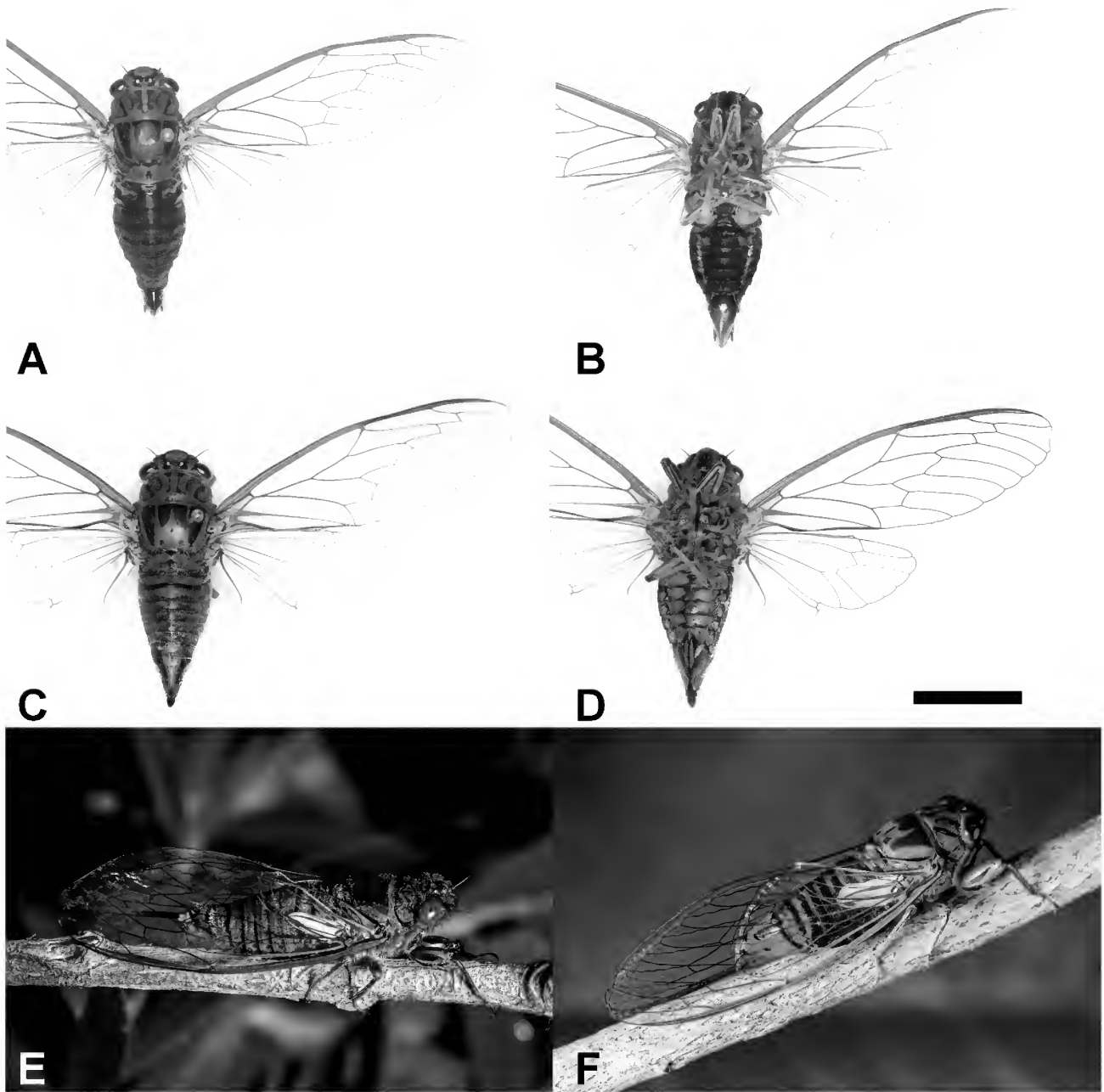
**Holotype** ♂, Park Ave., Waitara, NSW, 14.i.1983, T. A. Moulds, AM K.364604 (AM). **Paratypes** NEW SOUTH WALES: 1♀, N[ew] E[ngland] Nat. Park, NSW, near entrance, 13.xi.1960, C. W. Frazier, at light, ANIC database no. 20 010695; 3♂♂, 28°35'S 153°23'E, Plot Forest Rd, 3 km NNE of Minyon Falls, Whian Whian State Forest, NNE of Lismore NSW, 17.xi.1982, D. C. F. Rentz & C. D. MacNeill, Stop 93; 1♂, 35°58'S 150°09'E, Congo, 8 km SE by E of Moruya, NSW, 17.ii.1981, M. S. Upton; 1♂, 5 km NW of Torrington, NSW, 18–22.xii.1990, A. I. Night (ANIC); 1♂, *Melampsalta picea*, South Coast 1968 (Ashton collection; AM K.307116); 1♂, Killara 2071, 2.ii.77, S. M. Jones (AM K.307117); 1♂, Oberon, NSW, xii.1923, MH Anderson (AM K.307118); 1♂, Leura, NSW, 5.i.1933 (no name, AM K.307121); 1♀, Mt. Tomah, NSW, 6.xii.1980, NW Rodd (AM K.307119); 1♂, Hazelbrook, NSW, xii.1984, M. Dingley (AM K.307120); 1♂, Wombarra, NSW, 19.xi.1991, F. Douglas (AM); 1♂, Sydney, 20.ii.1965, V. Zadeh; (QM); 2♂♂, Duc kmaloi, NSW, 33°42'S 149°58'E, 26.xii.1949, (HEM2560–01) (MMV); 1♀, Park Ave, Waitara, NSW, 13.xii.1990, M. S. & B. Moulds; 1♂, Beach Rd, Harley Hill nr Berry, NSW, 34°46'40"S 150°44'01"E, 11.i.1993, D. Emery; 1♂, same location, 24.xii.2003, D. Emery; 1♂, Kinka Reserve, Terrey Hills, NSW, 33°40'39"S 151°12'00"E, 14.xii.1997, D. Emery; 1♂, same location, 14.xii.1998, D. Emery; 1♂, Barrington Tops, NSW, 18.xii.2001, R. Chin; 2♂♂, Vale St., Gordon, NSW, 33°45'23"S 151°08'42"E, 5.ii.2007, J. Slapeta; 16♂♂, same location, 1–5.i.2008, J. Slapeta; 3♂♂, same location, 1–4.i.2009, J. Slapeta; 1♀, South Taree, NSW, 31°55'26"S 152°27'52"E, 3.xi.2009, N. & D. Emery; 1♀, Kinka Reserve, Terrey Hills, NSW, 33°40'39"S 151°12'00"E, 28.xii.2009, P. Gillies; 1♂, same location, 15.i.2016, P. Gillies; 1♂, Roseville, NSW, 22.i.[20]11, J. Slapeta; 1♂ same location, 30.xii.2011, J. Slapeta; 1♀, Buchanan, NSW, 32°49'40"S 151°32'09"E, 9.i.14, G. Madani; 1♂, Thirroul, NSW, 2.iii.[20]14, R. Jones; 1♂, Crescent Head, NSW, 31°17'31"S 152°57'52"E, 19.xi.2016, N. & D. Emery; 1♂, Barrington Tops, NSW, 18.xii.2001, R. Chin; 1♂, Echo Point, Bundanoon, NSW, 34°41'05"S 150°17'24"E, 23.i.2012, C. & D. Emery; 1♂, Anvil Rock, NSW, 33°35'44"S 150°50'19"E, 4.xii.2012, D. Emery; 2♂♂, Evans Lookout, Blackheath, NSW, 33°36'59"S 150°16'29"E, 1000 m, 5.xii.14, D. & C. Emery; 3♂♂, Medway, NSW, 34°29'26"S 150°16'27"E, 585 m, 6.i.2017, S., N. & D. Emery & T. Corbin; (DE); 1♂, Beach Rd, Harley Hill, 24.xii.03, D. Emery; (LWP); 1♂ 1♀, Waitara, Sydney, 24.xi.1980, M. S. & B. J. Moulds; 1♀, same data, 26.i.1985; 2♂♂ 1♀, same data, 1.iii.1985;

2♂♂ 2♀♀, same data, 11.xi.1976, em[er]ged; 1♀, same data, 10.xi.1976, em[er]ged; 1♀, same data, 11.x.1976, emerged in afternoon; 1♀, same data, 7.i.1989; 1♂, same data, 17.x.1983; 1♂, same data, 28.xi.1976; 1♂, same data, 20.i.1985; 1♂, same data, 15.ii.1983; 1♂, same data, 29.i.1979; 1♂, same data, 20.ii.1980; 6♂♂, same data, 8.ii.1983; 4♂♂, same data, 23.i.1983; 1♂, same data, 5.ii.1986; 1♂, same data, 9.ii.2000; 1♂ 1♀, same data, 23.i.1983; 3♂♂, same data, 6.ii.1983; 2♂♂, same data, 7.ii.1983; 7♂♂, same data, 8.ii.1983; 1♂, same data, 3.ii.1993; 1♂, same data, 5.x.1985; 1♂, same data, 13.ii.1978; 1♂, same data, 4.xi.1977; 1♂, same data, 29.viii.1981; 1♀, same data, 17.ix.1979; 1♂, same data, 23.xii.1977; 1♂, same data, 2.xi.1985; 1♂, same data, 19.ix.1981; 1♀, same data, 12.xi.1980; 1♂, same data, 10.x.1997; 1♂, same data, 11.ii.1984, genitalia preparation; 2♂♂, same location, 25.ix.1984, T. A. Moulds; 1♂, same location, 23.i.1983, T. A. Moulds; 1♂, same location, 31.i.1985, T. A. Moulds; 1♂, same location, 17.ix.1987, T. A. Moulds; 1♂, same location, 15.ii.1983, T. A. Moulds; 1♂, Mt Kaputar, Dawson Springs, 2 km E of summit, 1400 m [elev.], 12.xii.1987, B. & S. Underwood; 3♂♂, Lemann Compound, ca 10 km SE Bowral, 34°32.50'S 150°29.20'E, 24.xii.1996, C. Lemann & S. McEvey, 12891, 12893–94; 1♂, Henry River Gorge, approx. 2 km below Henry River Falls via Glen Innes, 11.xii.1966, M. S. Moulds; 2♂♂ 1♀, Bark Hut Camping Area, Mt Kaputar Nat. Pk, 30°17'S 150°09'E, 1180 m [elev.] at mercury vapour lamp, 10.xii.1987, G. R. Brown and S. and B. Underwood; 1♂, Bark Hut, Mt Kaputar Nat. Pk, 10.xii.1987, S. & B. Underwood; 1♂, Mt Kaputar, Nandewar Rgs, 23.x.1965, M. S. Moulds; 1♂, Swampy Plains R., near Geeki, Snowy Mts, 29.xii.1979, P. S. Valentine; 1♀, Ulladulla, 23.xii.1994, M. S. & B. J. Moulds; 1♀, Stewarts Brook S. F., nr Barrington Tops, 11.xii.1987, B. C. White; 1♂, Bungonia Caves, 10.xii.1998, T. A. Moulds; 1♂, Berkeley Vale, 6.ix.2003, Mark Chambers; 1♂, Avoca Beach nr Gosford, 15.xi.1985, S. Hunter & A. L. Johnson; 1♀, Avoca Beach, 20.xii.1987, S. Hunter; 1♀, Greenwich, Sydney, 23.xii.1960, M. S. Moulds; 1♂, same data, 5.ii.1971; 1♂, same data, 14.i.1965, found dead; 1♂, same data, found dead, genitalia preparation; 1♂, same data, 4.xii.1981, M. S. & B. J. Moulds; 5♂♂ 1♀, Macksville, xii.1985, S. Lamond, [1♂ genitalia preparation]; 1♂, Avoca Beach, 19.xi.1986, S. Hunter & A. L. Johnson, at UV light; 1♂ 1♀, Waitara, 11.ii.1984, M. S. & B. J. Moulds; 1♂ 1♀, Davidson, Sydney, 23.xi.1983, J. F. Saunders; 1♂, Goonderra Ridge, Royal National Park, 18.xi.1978, G. & A. Daniels; 1♂, Knight's house, Avoca Beach, 4.i.1985, S. G. Hunter; 1♂, same data, 4.i.1984; 1♀, Mt Gibraltar, S. Rim, of Comboyne Plateau, 24.xii.1985, G. W. Williams, ex. wet/dry sl[erophyll] f[lorest] interface; 1♀, Katoomba district, 17.i.1970, C. E. Lazer; 1♂, Lane Cove, Sydney, 10.ii.1984, B. & S. Underwood; 1♂, Dural, 8.ii.1983, J. Frazier; 1♂, W Pymble, near Sydney, 3.i.1982, D. J. Scambler; 1♂, same data, 12.i.1982, genitalia preparation; 1♂, Lansdowne, near Taree, 27.xi.1980, M. S. & B. J. Moulds; 1♂, Turramurra, Sydney, 5.i.1972, M. S. Moulds; 1♂, Wahroonga, Sydney, xii.1985, S. Lamond; 1♂, Waitara, Sydney, 27.xii.1982, J. F. Saunders; 2♂♂, Waitara, 29.i.2005, D. Marshall; 1♂, Normanhurst, 23.ix.2003, C. Goldman; 1♂, St Ives, ix.2003, T. Hartwig; 1♂, Mandalong, 30.ix.2003, Philip Davies; 4♂♂, Hornsby, Sydney, 33°42'S 151°06'E, 8.ii.2004, Cooley, Hill, Marshall, Moulds, NSW.HPK; 1♂, Hornsby, ii.2000, M. Humphrey; 1♂, 24 Orana Ave, Asquith, Sydney, 33°41.152'S 151°06.243'E, 194 m [elev.], 5.xii.2005, Chen, Hill, Marshall, Moulds, AU.NS.ASQ; 2♂♂, Hornsby, Sydney, 33°42'S 151°06'E, 182 m [elev.], 8.ii.2004, Cooley, Hill, Marshall, Moulds, 04.NSW.HPK (MSM). 1♂, Wahroonga, NSW, 29°12'S 151°53'E, 22.ii.1953 (MMV). AUSTRALIAN CAPITAL TERRITORY: 1♂, ACT, Canberra, ANU campus, 5.xii.1990, C. Reid, at light; 1♀, Black Mtn, Canberra ACT, 15.xii.1964, L. J. Chinnielz, ANIC Database No. 20 010702; 1♂, Canberra ACT, 12.xii.1956, ANIC Database No. 20 010699 (ANIC); 1♀, Frith Rd, O'Connor, ACT, 35°16'07"S 149°06'32"E, 24.xi.2009, D. Emery & L. Popple; 1♂, Canberra Botanic Gardens, 22.xii.2016, J. Deland (DE); 1♂, Frith St, Acton, 35°15'58"S 149°06'34"E, 22.xi.2010, L. W. Popple, D. Emery, 510-0004; 3♂♂ 1♀, same data, L. W. Popple, 510-0010, 510-0012, 510-0014, 510-0015; 1♂ [damaged], Bruce, 35°15'S 149°05'E, 16.xi.2009, A. D. Stewart, at light (LWP); 1♀, [abdomen missing], Aranda, 28.xii.2003, S. Robertson (MSM). QUEENSLAND: 1♀, Tamborine Mt, C. Deane; 1♀, Binna Burra, Deane (QM); 3♂♂, Tamborine Mt, C. Deane (UQIC); 1♂ 1♀, Governor's Chair, Spicers Gap, 28°05'07"S 152°25'03"E, 2.i.2013, L. Popple, A. McKinnon, 509-0012, 509-0013 (LWP); 1♂, Kroombit Tops, 65 km SW. of Gladstone, 3.ii.1984, C. E. Hagan, open wet sclerophyll forest; 1♂, Kroombit Tops (Beauty Spot 98), 45 km SSW Calliope, 3–4.ii.1983, Monteith, Hagan & Yeates, open for[est]; 1♀, Springbrook area (near Brisbane), 19.xii.1975, R. B. Lachlan (MSM).

**Additional published records.** NEW SOUTH WALES: Gibraltar Range, 29°29'S 152°22' (Moss & Popple, 2000) QUEENSLAND: Kroombit Tops, 24°21'S 150°58'E (Ewart, 1986).

**Additional locations with audio recordings.** NEW SOUTH WALES: Forest Track, Royal National Park, NSW, 25.xi.2012, B. Smith; Blatherarm Camping





**Figure 7.** *Yoyetta timothyi* sp. nov., brown forms: (A) male holotype, Waitara (33°42'S 151°06'E), dorsal habitus; (B) male holotype, Waitara, ventral habitus; (C) female, Terrey Hills (33°40'S 151°12'E), dorsal habitus; (D), female paratype, Terrey Hills, ventral habitus; (E) male, Crescent Head (31°17'S 152°57'E), live specimen (photo by NJE); (F) female, Medway (34°29'S 150°16'E), live specimen (Photo by NJE) Scale bars = 10 mm.

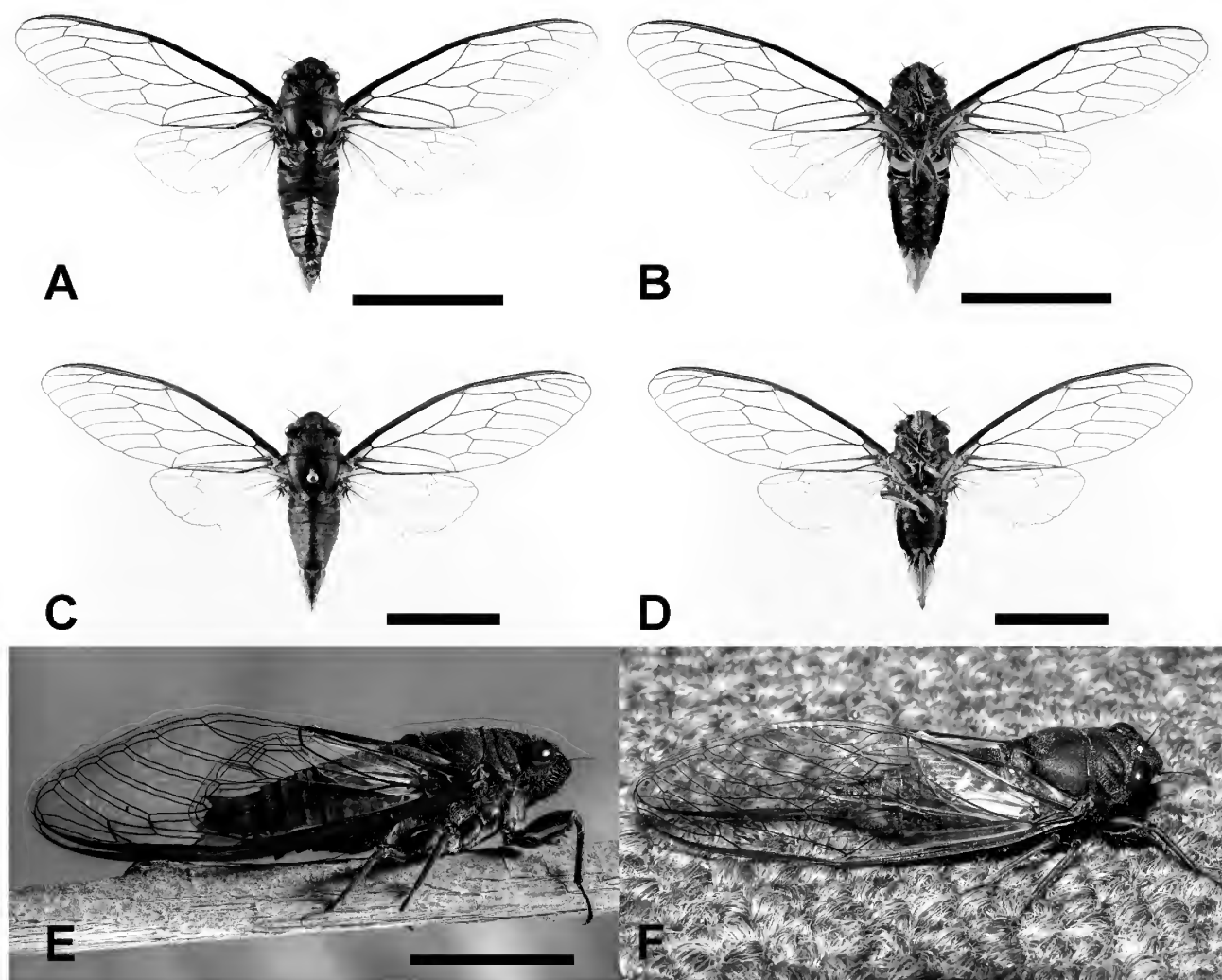
Area, Torrington State Conservation Area, NSW, 29°15'08"S 151°42'26"E, 4.i–8.i.2016, L. W. Popple; Bismuth Dam, Torrington State Conservation Area, NSW, 29°15'13"S 151°38'20"E, 6.i.2016, L. W. Popple; Old Grafton Rd, Glen Elgin, NSW, 29°39'20"S 152°02'38"E, 7.i.2016, L. W. Popple. QUEENSLAND: Mt Tennison Woods, Qld, 27°17'S 152°44'E, 21.xi.2003, L. W. Popple; Daves Creek, Lamington National Park, Qld, 28°13'21"S 153°12'35"E, 12.xii.2017, L. W. Popple; Spicers Gap, Main Range National Park, Qld, 28°05'07"S 152°25'03"E, 2.i.2013, L. W. Popple.

**Distribution, habitat and seasonality.** Known from Kroombit Tops in southeastern Queensland, south along the ranges and subcoastal forested areas to the south coast of New South Wales and inland to the Australian Capital Territory (Fig. 5). An isolated population occurs at Mt Kaputar on the northwestern slopes of New South Wales

(Fig. 5). This record was previously attributed to *Y. denisoni* by Moulds (1990). Adults are active in the upper canopy of eucalypt forest. They are present from November to January and occasionally also in February.

### Description

**Male** (Figs 2A; 3A; 7A,B,E; 8A,B,E,F; 10B; 52A). *Head* approximately as wide as mesonotum; predominantly dull brown to black, black around ocelli, narrowing anteriorly around margins of postclypeus, black spot on medial margin of eye, a brown to orange-brown central marking on posterior dorsal area extending between lateral ocelli and through dorsal



**Figure 8.** *Yoyetta timothyi* sp. nov., black form: (A) male, O'Connor (35°16'S 145°06'E), dorsal habitus; (B) male, ventral habitus; (C) female, O'Connor, dorsal habitus; (D), female, ventral habitus; (E) male, Medway (34°29'S 150°16'E), live specimen (Photo by NJE); (F), male, O'Connor, live specimen (Photo by LWP). Scale bars = 10 mm.

postclypeus, greenish in some specimens; ocelli red, clear in many preserved specimens; postclypeus predominantly black to brown above, with black anterior margin, ventrally black, with black transverse grooves with orange-brown lateral and posterior margins, rounded laterally; frons orange-brown; anteclypeus black with small brown central marking; lora dark brown to black; gena black; rostrum black anteriorly, broadly ochraceous centrally, black at apex, extending to anterior margins of hind coxae; eyes brown to dull black; antennae black, supra-antennal plates brown.

*Thorax* ranging from brown to black; pronotum brown to black with a central orange-brown line, flanked with black markings, paramedian fissures variably brown and black, lateral fissure black, with patchy and variable black markings on ridges between fissures; pronotal collar brown to black with variable black mottling on lateral margins; mesonotum with central and lateral regions dark brown to black, submedian and lateral sigilla black; parapsidal sutures black; cruciform elevation black, lateral depressions brown; scutal depressions black; wing grooves dark brown to orange-brown; metanotum black.

*Legs* with coxae striped black and light brown, coxal

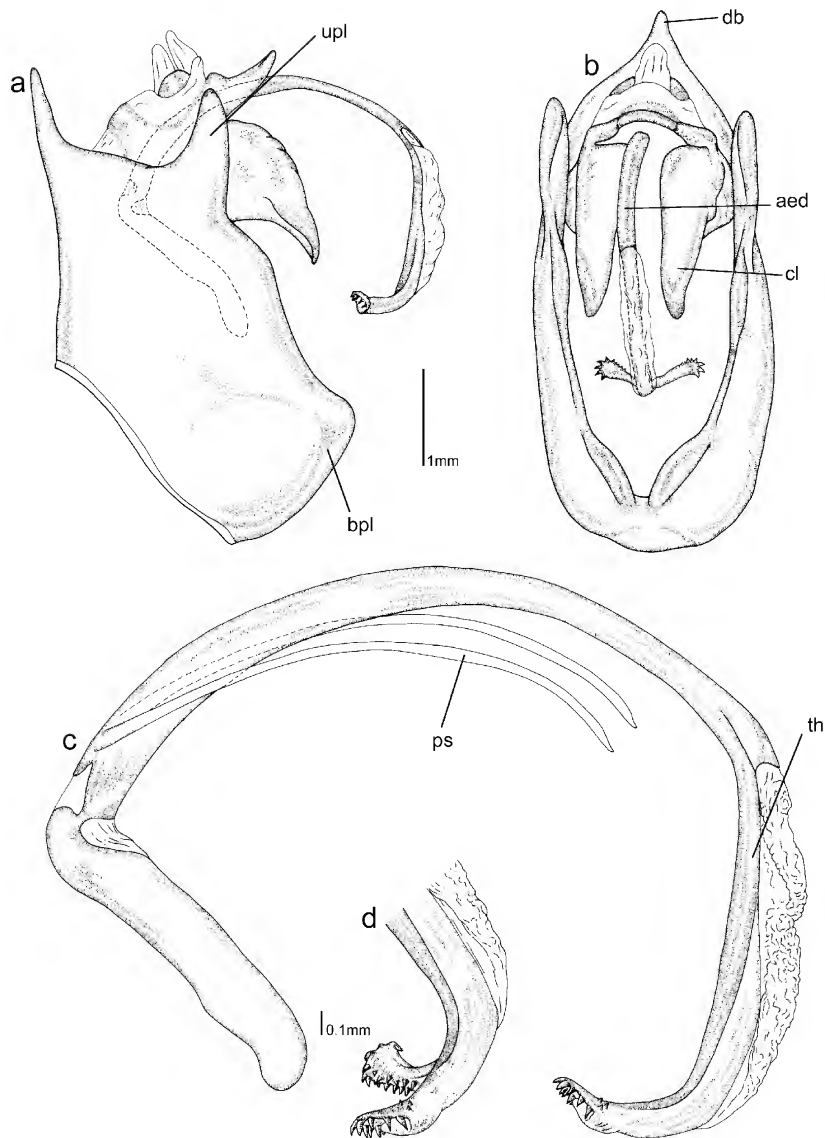
membranes red-orange; coxal joints bright orange-red, trochanters orange-brown; meracantha small brown, slight curved, pointed, black at base, minimally overlapping opercula; femora striped black and brown with reddish stripe laterally; fore femoral spines erect, brown at base becoming darker towards tip; joints orange to red; tibiae black anteriorly, brown to yellowish posteriorly medially, with spines variably pale to dark brown; tarsal joints orange; tarsi light brown, becoming darker brown towards claws; claws brown, black at tips.

*Wings* with fore wing costal veins brown to black, centrally reddish, pterostigma with reddish-brown mottling distally; basal membranes orange, dull orange or pale orange-white; basal cell translucent; other veins mainly dark brown to black proximally, black distally; with eight apical cells; hind wing plaga white, extending over jugum along vein 3A and medial third of anal cell 2, remainder of anal lobe diffuse white, veins brown, with six apical cells.

*Opercula* (Fig. 3A) spatulate, following body axis ventromedially; black at base, orange-red over remainder; clearly separated.

*Timbals* (Fig. 2A) with five distinct long ribs, long ribs 1–3





**Figure 9.** *Yoyetta timothyi* sp. nov., illustration of male pygofer and internal genitalia; (a) viewed laterally from the left; (b) viewed ventrally; (c) aedeagus; and (d) apex of theca. Characters as depicted in Fig. 4. Specimen from Gordon, New South Wales (33°76'S 152°15'E).

each spanning across timbal membrane and fused dorsally along basal spur, long rib 4 unfused medially, narrowing over third quarter; long rib 5 noticeably shorter than other long ribs; large ridged dome on posterior timbal plate extending across two-thirds of timbal; apodeme pit oval-shaped and conspicuous.

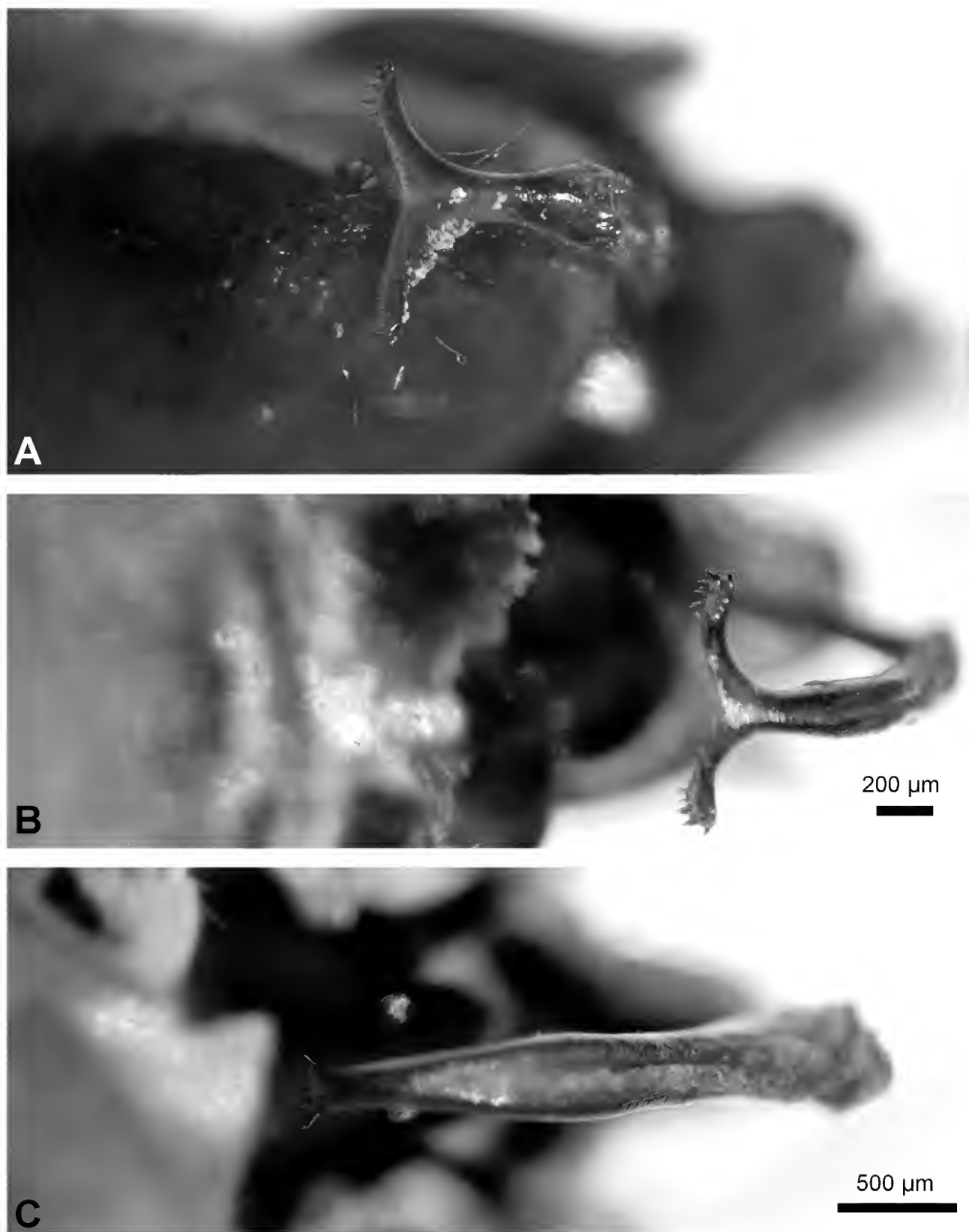
**Abdomen.** Tergites 1–8 black, with faint brownish markings on posterior borders of the central third of tergites 2–8. Sternite II black, ochraceous around posterior margin of tympanal cavity; sternite III black with orange-brown anterior margin and over lateral third on brown specimens; sternite IV black with orange-brown anterior margin widening to completely cover lateral third, small central ochraceous marking; sternites V–VII black with small pale brown markings near epipleurites; sternite VIII black on anterior margin, orange-brown over remainder, with yellowish pubescence.

**Genitalia** (Fig. 9, 10B). Pygofer mainly black dorsally,

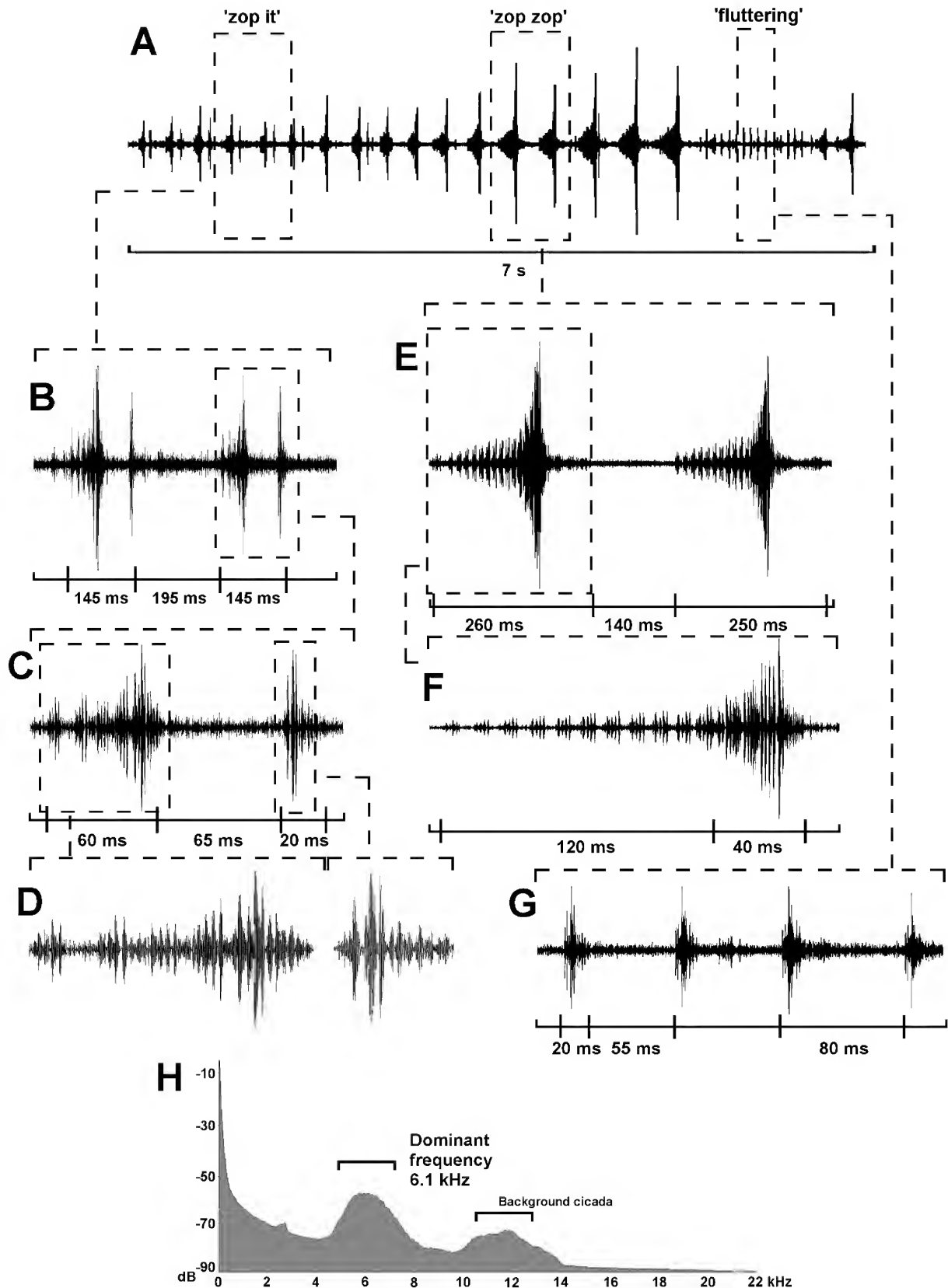
becoming pale brown laterally; dorsal beak black, brown at tip, upper lobe prominent, rounded, pale brown at tip, basal lobe dark brown to black; anal styles orange. Uncus brown, in lateral view beak-like, rounded distally; lobes in ventral view less produced, rounded laterally; claspers divided, with apices gradually tapering laterally. Aedeagus with pseudoparameres extending around half the length of theca; theca recurved ventrally at 180° towards apex, with prominent translucent flange along outer margin of recurvature, this smooth dorsally, thickness around diameter of theca; apex opaque, sclerotized, bifurcate, with prominent arms, each arm directed laterally at approximately 180°, with 2 rows of prominent cornuti (Fig. 10B).

**Female** (Figs 7C,D,F; 8C,D). **Head** and **thorax** similar to male, with coloration of brown areas ranging from green-brown to orange-brown.

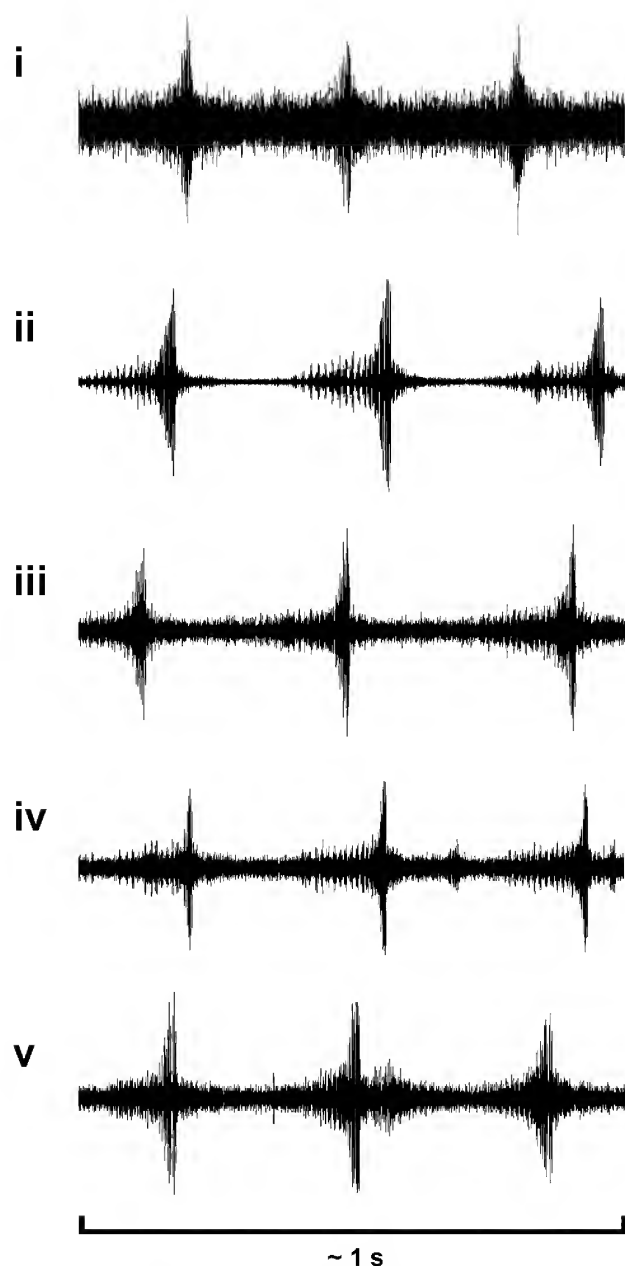
**Wings** similar to male. Fore wing basal membranes pale orange-white or orange.



**Figure 10.** Photostack comparisons of aedeagus of (A) *Yoyetta denisoni* (Distant), holotype (photo by J. Constant); (B) *Y. timothyi* sp. nov., Gordon (33°45'S 151°08'E); (C) *Y. kershawi* (Goding & Froggatt), Toolangi (37°32'S 145°28'E). Scale bars as indicated.



**Figure 11.** Male calling song structures of *Yoyetta timothyi* sp. nov. illustrated in waveform plots. These include: (A) an example of the song transitioning between the “zop-it”, “zop zop” and “fluttering” song modes (explained in more detail in text); (B) expanded section of the “zop it” mode (from A) showing two phrases, each containing a macrosyllable followed by a syllable; (C) further expanded detail of a single phrase from the “zop it” mode; (D) further expanded detail showing the detailed structure of the macrosyllable and syllable from a single phrase of the “zop it” mode; (E) expanded detail (from A) of two echemes from the “zop zop” mode; (F) further expanded (from E) to show the detailed structure of a single echeme from the “zop zop” mode; (G) expanded detail (from A) of the syllable sequence from the fluttering song mode (four syllables shown). The final subfigure (H) is a spectrogram displaying song frequency. This specimen was recorded in the field at Glen Elgin (29°39'S 152°03'E) by LWP using RS3 (see *Methods and terminology*).



**Figure 12.** Comparative structures of the “zop zop” calling song mode of *Yoyetta timothyi* sp. nov. in waveform plots, each displaying three echemes. These have been recorded from a range of locations, including (i) Lane Cove National Park (33°49'S 151°10'E); (ii) Glen Elgin (29°39'S 152°02'E); (iii) Tennison Woods (27°17'S 152°44'E); (iv) Daves Creek (28°13'S 153°13'E); (v) Canberra (35°16'S 149°07'E). Recordings were obtained by B. Smith using RS5 (i), and by LWP using RS1 (iii), RS2 (v) or RS3 (ii, iv).

**Abdomen** with tergites 1–8 black anteriorly, with orange-brown marking posteriorly, reducing laterally, wholly black on lateral margins. Sternites I and II black, anterior and lateral margins orange; sternite III, black, orange-red over lateral third; sternites IV–VIII orange-red with central black markings expanding at posterior margin of each sternite; epipleurites 1–3 red, 3–8 black anteriorly, posterior half black; abdominal segment 9 orange with anterior margins black, remainder orange with symmetrical black dorsal linear markings on either side of midline over anterior half, lateral black spot, dorsal beak black, anal styles orange with black

tips; ovipositor sheath brown; ovipositor reddish anteriorly, becoming black at tip, extending < 1 mm beyond dorsal beak.

**Measurements** (in mm; range with mean in parentheses: 18 males, 7 females). Body length: male 23.7–26.0 (24.7); female 23.5–26.4 (24.7). Fore wing length: male 24.4–31.2 (29.4); female 30.2–33.7 (31.2). Head width: male 6.4–7.4 (6.9); female 7.1–7.5 (7.4). Pronotum width: male 6.3–7.5 (6.8); female 7.1–7.5 (7.2). Abdomen width: male 6.4–7.6 (7.0); female 6.8–7.5 (7.1). Ovipositor length 6.5–8.2 (7.8).

**Colour forms.** It has come to the attention of the authors that *Y. timothyi* sp. nov. occurs in two broadly defined colour forms: brown and black. The brown form (as per the holotype) is characterized by the predominantly brown colour of the head and thorax (Fig. 7). In this form the fore wing basal membranes are orange to dull orange. It occurs in southern Queensland and in lower altitude areas of New South Wales (mainly below 600 m). In contrast, the black colour form is characterized by the predominantly black colour of the head and thorax (Fig. 8). In this form the fore wing basal membranes are orange to pale orange-white. It is restricted to higher altitude areas of New South Wales and the Australian Capital Territory (above 600 m). Localities where it has been collected include Torrington, Mt Kaputar, Barrington Tops, the Blue Mountains (at Anvil Rock, Evans Lookout and Blackheath), Bundanoon and Mt Gibraltar (Bowral) in New South Wales and O'Connor in the Australian Capital Territory. Notably, while no males of the brown form have been encountered in the Australian Capital Territory, females of both colour forms have been collected in the suburb of O'Connor.

**Etymology.** Named after Dr Timothy Moulds, who collected the holotype and an extensive series of this species over many years at Waitara in northern Sydney.

**Distinguishing features.** Male specimens of *Yoyetta timothyi* can be distinguished morphologically from other species of *Yoyetta*, apart from *Y. denisoni* and *Y. kershawi* stat. rev., comb. nov., by their size (forewing length > 27 mm) and the abdominal tergites, which are uniformly black without orange or yellow markings or contrastingly posterior margins. Males can be distinguished from *Y. kershawi* stat. rev., comb. nov. and *Y. denisoni* by examining the basal membranes of the fore wings, which are orange to pale orange-white (cf. bright red in *Y. kershawi* stat. rev., comb. nov. and *Y. denisoni*). They can be also distinguished from *Y. kershawi* stat. rev., comb. nov. by the presentation of the terminal aedeagus, which is strongly bifurcate and splayed into two lateral arms (cf. simple or weakly bifurcate, without lateral arms in *Y. kershawi* stat. rev., comb. nov.). Females of *Y. timothyi* can be distinguished from all other species of *Yoyetta*, apart from *Y. subalpina* sp. nov., *Y. serrata* sp. nov., *Y. kershawi* stat. rev., comb. nov. and *Y. denisoni* by their size (fore wing length > 30 mm) and the length of the ovipositor sheath, which extends < 1 mm beyond the posterior edge of abdominal segment 9. They can be distinguished from *Y. subalpina* sp. nov. and *Y. serrata* sp. nov. by the abdominal tergites 1–8, which are either entirely black or black with broad, reddish-brown posterior markings (and without strongly contrasting yellow or orange posterior bands). Females can be distinguished from *Y. kershawi* stat. rev., comb. nov. and *Y. denisoni* by examining the basal membranes of the fore wings, which may be orange or pale orange-white (cf. bright red to pink in *Y. kershawi* stat. rev., comb. nov. and *Y. denisoni*).

**Calling song** (Figs 11, 12, 53B). For the casual observer, *Y. timothyi* sp. nov. is generally heard calling in flight, with a distinct, simple and regular “zop zop zop” call. Like *Y. denisoni* (but with a slower emission rate), this predominant call mode is a chirping song. Further observations reveal that there is more to the calling song of this species, with up to three song modes being produced. The first song mode (produced mainly in flight), is referred to as the “zop zop” mode (illustrated in Figs 11A,E,F; 12). The zop zop mode consists of a single echeme spanning 0.13–0.25 s duration, followed by a gap of 0.17 and 0.33 s duration ( $n = 9$ ; Fig. 11E). This is typically repeated several times. Close inspection of the echeme reveals that the initial syllables are discrete (Fig. 11F). As the echeme progresses, the syllables coalesce and the sound is amplified sharply before ceasing abruptly (Fig. 11F). This zop zop mode is sometimes also heard in stationary males, particularly just before they take flight and continues in flight.

The second and third song modes have only been recorded from one individual at Glen Elgin, although they have been detected aurally at many other locations across the geographical distribution of the species. These modes are produced only by males when stationary or crawling, or flowing attraction to vegetation by “finger-snapping”. The second mode is referred to as a “zop it” (Figs 11A–D). From a single recording, the zop it mode is characterized by repeated phrases, each containing a long macrosyllable (0.06–0.09 s duration), a gap (0.06–0.08 s duration) and a syllable (c. 0.01 s duration) (Figs 11B & 11C). Close inspection of the long macrosyllable reveals that it comprises up to eight coalesced syllables, the second and third last two being noticeably higher in amplitude than the preceding ones (Fig. 11D). A gap between 0.10 and 0.15 s duration separates each phrase.

The third song mode (“fluttering”) is produced by stationary or crawling males between short bouts of the “zop zop” mode. The fluttering mode is composed of a rapidly-emitted series of syllables around 0.01 s duration separated by a gap ranging from 0.04–0.06 s duration (Figs 11A, 11G). From the single recording of a male at Glen Elgin, the fluttering mode contains around 16 syllables.

Along sandstone ridges in the Blue Mountains and Southern Highlands of NSW, flying males were observed meandering through the vegetation, including lower storey shrubs while producing the “zop zop” mode. It was found that these males could be attracted into close proximity by finger or tongue clicking broadly timed to mimic female wing-flick responses. Once landed, their song was found to alternate between the “zop zop” and fluttering song modes and, unless further attracted or caught, they would fly off within 10–15 seconds.

The highest amplitude frequency plateau for this species spans 4.7–7.0 kHz, with a dominant frequency from 5.4–6.6 kHz (Fig. 11H).

The calling song of *Y. timothyi* sp. nov. is distinctive within the genus and is most similar to the call of *Y. denisoni*. The principal difference is in the emission rate, with *Y. timothyi* sp. nov. emitting echemes in the zop zop mode at a rate of 2–3 per second compared with 5–6 shorter (macro)syllables per seconds for *Y. denisoni*. In bushland around Canberra, both species can be heard calling in flight, sometimes concurrently.

## *Yoyetta kershawi* (Goding & Froggatt, 1904) stat. rev., comb. nov.

Figs 2H, 3L, 10C, 13, 14

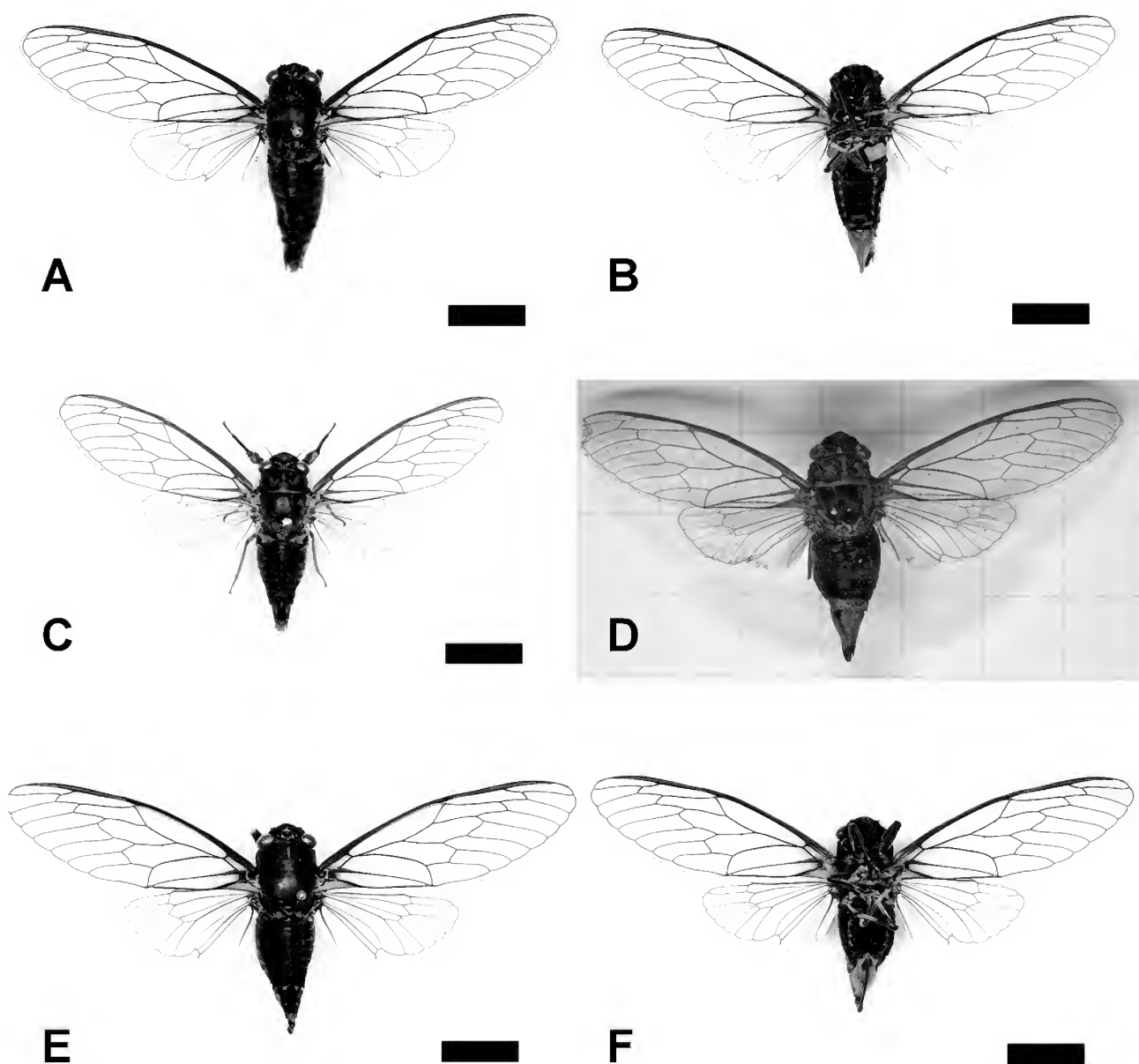
*Melampsalta kershawi* Goding & Froggatt, 1904: 636;  
Distant, 1906: 176.

Synonym of *Melampsalta denisoni* Ashton, 1912: 25; Burns,  
1957: 650; Moulds and Cowan, 2002: 26.

The holotype of *Y. kershawi* stat. rev., comb. nov. is a female from Marysville in Victoria. Males from the vicinity of type locality and elsewhere in Victoria consistently have a markedly different shaped aedeagus from the holotype of *Y. denisoni* (see Fig. 10), as well as other specimens matching *Y. denisoni* from New South Wales (e.g., Fig. 9). Males with an aedeagus shape characteristic of *Y. denisoni* have not been found in Victoria. On the basis of this morphological difference, we hereby raise *Y. kershawi* stat. rev., comb. nov. from synonymy.

**Material examined.** VICTORIA: *Holotype* female (by monotypy), [handwritten] “*Melampsalta kershawi*”, “GandF ♀ type” / “Marysville” [no collector or date] / “Det by Goding & Froggatt, 1904” (T14237, MMV). 1♂ 2♀♀, Country Fire Authority Station, Toolangi, 37°32'32"S 145°28'29"E, 436m, 11.i.2017, S. Emery & T. Corbin (at light); 2♂♂ 2♀♀, same location, 27.xii.2018, S. Emery & T. Corbin (at light) (T 22393–4 [♀], T22935–6 [♂]); 8♂♂, Tennyson Creek, 5 km NW of Buldah, Vic, 37°14'S 149°07'E, 1–16.i.1982, ANZSES Expedition (HEM2545–53) (MMV); 1♂, 38°55'S 146°22'E, nr Barrys Ck, Wilsons Promontory, Vic, 3.i.1989, J. Balderson; 2♂♂, 36°56'S 148°12'E, 3 km NNE Mt Wombago, E of Benambra, Vic., 29.xii.1983, 1417 m, K. W. L. Key, ANIC Database Nos 20 010696, 20 010700 (ANIC); 1♂, Fernshaw, 11.xii.1919]26, E. B.; 1♂, Belgrave, 1.i.1949, N. I. A. Webb (UQIC); 1♀, S Gippsland, (no date) (Ashton collection; AM K.307127); 2♂♂, Dunmoochin, 1.5 km NE Cottles Bridge, 37°37'23"S 145°13'13"E, 27.x.1998, F. Douglas; 23♂♂ 4♀♀, Country Fire Authority Station, Toolangi, 37°32'32"S 145°28'29"E, 436m, 11.i.2017, S. Emery & T. Corbin (at light); 12♂♂ 4♀♀, same location, 27.xii.2018, S. Emery & T. Corbin (at light); 1♀, Dandenong Range National Park., 28.xii.2016, L. Rogan (DE); 1♂, Morwell National Park, 31.i.1995, K. Harris, 510-0001; 1♀, Dandenong Range, Lyrebird track, 37°53'10"S 145°22'15"E, 27.xii.2010, A. Thornhill, 510-0011 (LWP); 6♂♂ 8♀♀, N. Walkerville, 28.xii.1988, H. Abbott; 3♂♂ 3♀♀, same data, 2.i.1989; 1♂, same data, 9.i.1989; 1♂, same data, 10.i.1989; 1♂ 1♀, same data, 13.i.1989; 1♂, same data, 16.i.1989; 1♂, same data, 27.xii.1989; 2♀♀, same data, 27.xii.1988; 1♂, Reeves Beach, nr Woodside, 16.i.1989, H. Abbott; 8♂♂ 1♀, 10 km E of Warburton, 6.i.1987, G. & J. Burns; 6♂♂ 3♀♀, Mt Oberon, 2.i.1989, K. L. Dunn; 5♂♂ 3♀♀, Mt Oberon, Wilsons Prom., 2.i.1989, K. L. Dunn, found dead; 2♂♂, Healesville, 25.i.1992, C. Rojewski; 1♂, Norman Bay, tidal river, Wilsons Promontory, 14.i.1986, K. L. Dunn; 1♀, Hurstbridge, 2.i.1986, T. R. New; 1♀, Waldron Mtn, near Cann River, 31.xii.1975, M. S. Moulds; 2♂♂, Warburton, 14.xii.2007, Stephen Smith; 2♂♂, same data, 7.i.2011; 4♂♂, Starvation Ck, McMahon Creek township, 1.i.2011, Stephen Smith; 4♂♂, same data, 9.i.2011; 3♂♂ 4♀♀, Starvation Ck, nr McMahon Creek township, 37°45'S 145°51'E, 23.xii.2007, S. Smith; 1♀, same data, 25.xii.2007 (MSM). NEW SOUTH WALES: 10♂♂ 16♀♀, Frank Tetley Park, nr Fred Piper Lookout, Brown Mtn, nr Bega, 9–12.i.1982, M. S. & B. J. Moulds (MSM).

**Distribution, habitat and seasonality.** This species inhabits cool temperate eucalypt forest in far southern New South Wales and northern and eastern Victoria where it extends from east Gippsland south and west through the Great Dividing Range to the Greater Melbourne region and Wilsons Promontory (Fig. 5). Adults are present between November and January and occur principally in the upper canopy. Most specimens have been collected at light. Large emergences are known to occur, although these appear to be infrequent.



**Figure 13.** *Yoyetta kershawi* (Goding & Froggatt) stat. rev., comb. nov. (A) male Toolangi, (37°32'S 145°28'E) dorsal habitus; (B) male Toolangi, ventral habitus; (C) male, Dunmoochin (35°16'S 145°06'E), dorsal habitus; (D) holotype female, Marysville (37°30'S 145°44'E), dorsal habitus; (E), female Toolangi, (37°32'S 145°28'E) dorsal habitus; (F) female Toolangi, (37°32'S 145°28'E) ventral habitus. Scale bars = 10 mm.

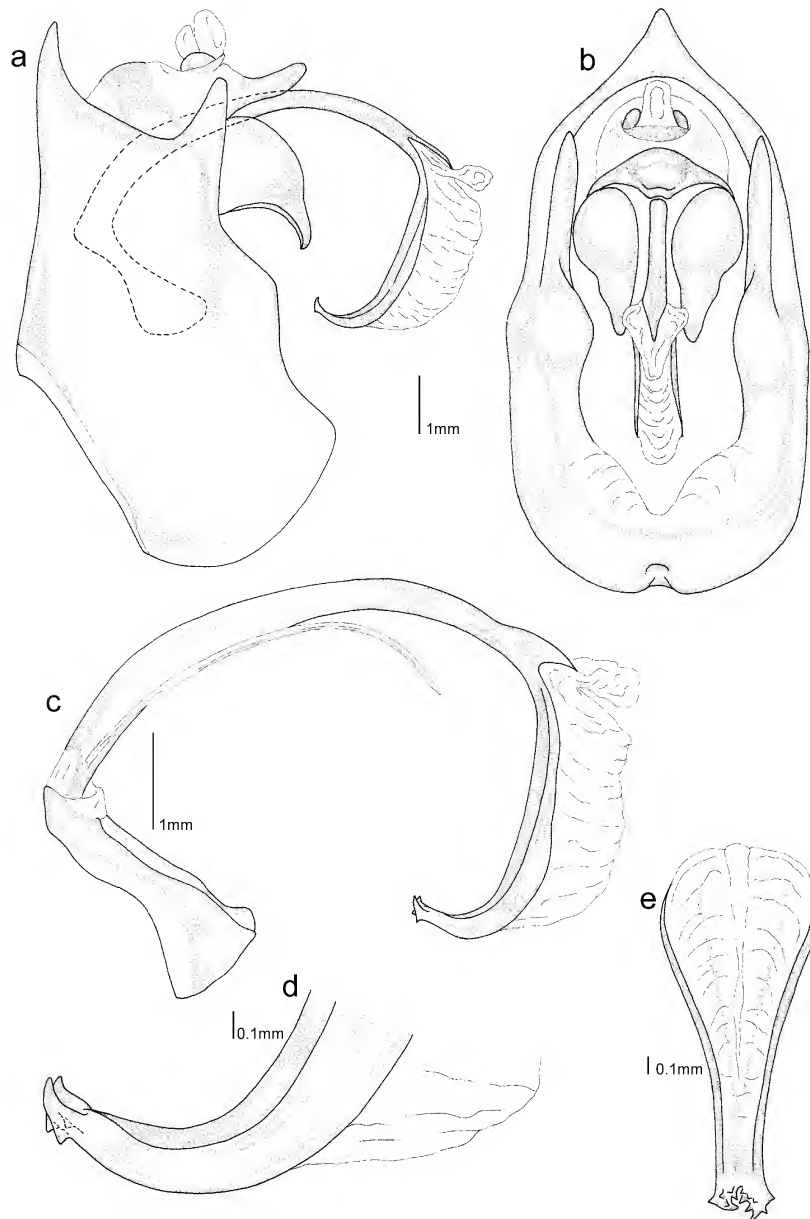
### Description

**Male** (Figs 13A–C, 14). *Head* approximately as wide as mesonotum; most specimens predominantly dull black, with a brown to orange-brown central marking on posterior dorsal area extending between lateral ocelli and through dorsal postclypeus; ocelli pink to red; postclypeus predominantly black, with circular dull reddish-brown markings above either side of central orange line, black transverse grooves below with orange-brown lateral and posterior margins, rounded laterally; lora black; gena black; anteclypeus black; rostrum black anteriorly, variably ochraceous centrally, black at apex, extending to posterior margin of middle coxae; eyes brown to dull black; antennae black, supra-antennal plates black.

*Thorax* almost entirely black (or sometimes a mix of dark brown and black); pronotum predominantly black,

paramedian and lateral fissures black with intermediate ridges variably dull orange-brown laterally on lighter coloured specimens; pronotal collar black, brown in some specimens, sometimes with central lateral section ochraceous posteriorly. Mesonotum black, cruciform elevation arms black, lateral depressions brown; scutal depressions black; parapsidal sutures black; metanotum black.

*Legs* with coxae black; coxal joints bright red; meracantha small creamy, pointed, black at base, partly overlapping opercula; trochanters red; meron reddish; fore femora striped black and red; mid and hind femora with lateral and anterior surfaces black, inner side ochraceous to dark brown; femoral joints orange to pale yellow; tibiae black to dark brown laterally becoming ochraceous medially and towards base, with fore tibial spines black, mid and hind tibial spines variably pale brown and black at tips; tarsal joints orange;



**Figure 14.** *Yoyetta kershawi* (Goding & Froggatt) stat. rev., comb. nov.: illustration of male pygofer and internal genitalia; (a) viewed laterally from the left; (b) viewed ventrally; (c) aedeagus; (d) apex of theca, viewed laterally from left; and (e) apex of theca, viewed ventrally. Characters as depicted in Fig. 4. Specimen from Toolangi (37°32'S 145°28'E).

tarsi dark brown, becoming black towards claws; claws brown, black at tips.

*Wings* with fore wing costal veins typically black (sometimes brown); pterostigma with reddish-brown mottling; basal membranes vivid red; basal cell translucent brown; veins mainly black to dark brown, with eight apical cells; hind wing plaga white, extending over medial third of anal lobe, remainder of anal lobe diffuse white, veins mainly brown, CuA black proximally, brown after junction, with six apical cells.

*Opercula* (Fig. 3L) medium, spatulate, following body axis ventrolaterally; black at bases, red over remainder, including crests; clearly separated.

*Timbals* (Fig. 2H) with five distinct long ribs, long ribs 1–4 each spanning across timbal membrane and fused dorsally

along basal spur; long rib 4 narrowing over third quarter; long rib 5 noticeably shorter than other long ribs; large ridged dome on posterior timbal plate extending across two-thirds of timbal; apodeme pit oval-shaped and conspicuous.

*Abdomen* with tergites 1–7 black, tergite 8 black, lateral margins red. Epipleurites black. Sternite I black, partly ochraceous around inner surface of tympanal cavity; sternite II black with small central ochraceous marking; sternites III–VII black, posterior margin of sternite VII red; sternite VIII black on anterior margin, bright red over remainder, with black to pale brown pubescence.

*Genitalia* (Figs 10C, 14). Pygofer mainly black; dorsal beak black, upper lobe prominent, pointed, red at tip; basal lobe dark brown to black; anal styles bright red. Uncus



red, in lateral view beak-like and stumpy; lobes in ventral view less produced, rounded laterally; claspers divided, closely applied, with apices gradually tapering laterally. Aedeagus with pseudoparameres extending around half the length of theca; theca gradually recurved ventrally at 180° towards apex, with translucent flanges along outer margin of recurvature, these smooth dorsally, > 2× diameter of theca, tapering towards apex of theca; apex transparent, sclerotized, knob-like, sometimes weakly bifurcate (Fig. 10C), with multiple small cornuti on ventral border.

**Female** (Fig. 13D–F). *Head* and *thorax* similar to male, generally with blacker coloration. Colour morphology ranges from brown to black (Figs 13D–E).

*Wings* similar to male, with basal membranes typically vivid red.

*Abdomen* with tergites 1–8 black. Sternites I–VIII black, red posterior margin on Sternite VIII; abdominal segment 9 black dorsally with two small, orange, triangular spots either side of midline, orange laterally with posterior black spot, red ventrally, dorsal beak black; anal styles and ovipositor sheath red; ovipositor dark brown to black, extending up to approximately 1 mm beyond dorsal beak.

**Measurements** (in mm; range with mean in parentheses: 12 males, 8 females). Body length: male 24.5–28.4 (26.6); female 25.6–28.0 (27.0). Fore wing length: male 28.2–32.4 (30.0); female 30.6–34.5 (32.5). Head width: male 6.8–7.3 (6.9); female 7.2–8.0 (7.6). Pronotum width: male 6.5–7.0 (6.8); female 7.5–8.2 (7.8). Abdomen width: male 6.8–7.8 (7.4); female 7.6–8.9 (8.2). Ovipositor length: 8.2–9.0 (8.7).

**Colour forms.** *Yoyetta kershawi* stat. rev., comb. nov. occurs in two broad colour forms: brown and black. The brown form (as per the “type” female and Fig. 13D) is characterized by a mixture of brown and black colouration on the thorax and brown along the costal veins (Fig. 13A,B,E,F). The black strongly predominates, particularly in male specimens.

**Distinguishing features.** Apart from *Yoyetta denisoni* and *Y. timothyi* sp. nov., *Y. kershawi* stat. rev., comb. nov. is readily distinguished morphologically from all other species of *Yoyetta* in the abdominalis group using the following combination of characters: (1) large size with body length > 23 mm and forewing length > 28 mm; (2) contrasting black and red markings with red coloration confined to coxal joints and fore femora, basal membranes, sternite VIII and opercula (male), coxal joints, fore femora and ventral and lateral surfaces of abdominal segment 9 (female); (3) black coloration of sternites. Males of *Y. kershawi* stat. rev., comb. nov. can be distinguished from *Y. denisoni* and the black colour form of *Y. timothyi* sp. nov. by the simple, knob-like apex of the aedeagus, in contrast to the terminus of the other two species, which is heavily bifurcated and splayed into two lateral arms. Females of *Y. kershawi* stat. rev., comb. nov. can be distinguished from *Y. timothyi* sp. nov. by examining the basal membranes of the fore wings, which are vivid red to pink (cf. orange, pale orange-white in *Y. timothyi* sp. nov.). Females of *Y. kershawi* may be indistinguishable from *Y. denisoni*, although the latter species is separated geographically, apparently being restricted to New South Wales.

**Calling song.** The calling song of *Y. kershawi* stat. rev., comb. nov. has not been recorded to date.

## *Yoyetta abdominalis* (Distant, 1892)

Figs 2G, 3G, 15–17, 52F, 53I

*Melampsalta abdominalis* Distant, 1892: 323; Goding & Froggatt, 1904: 634; Distant, 1906: 170; Froggatt, 1907: 353; Ashton, 1912: 1912; Ashton, 1914: 352; Tillyard, 1926: 161; Burns, 1957: 646.

*Cicadetta abdominalis*.—Moulds, 1990: 155–156, Plate 17, Figs 7, 7a; Moss, 1990: 6.

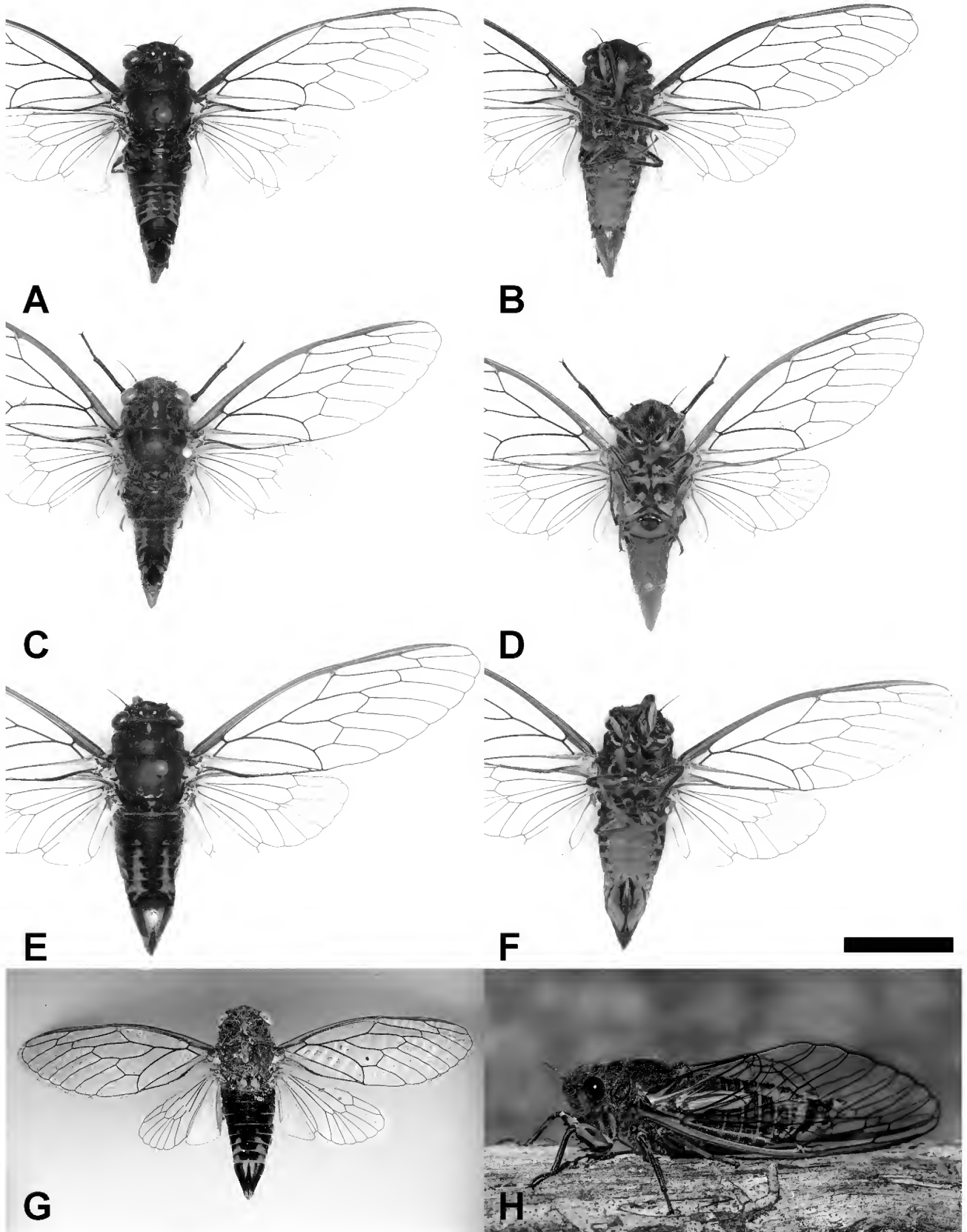
*Yoyetta abdominalis*.—Moulds, 2012: 24, 235; Sanborn, 2014: 553.

*Cicadetta* sp. aff. *abdominalis* (“Tea tree firetail”).—Haywood, 2007: 14.

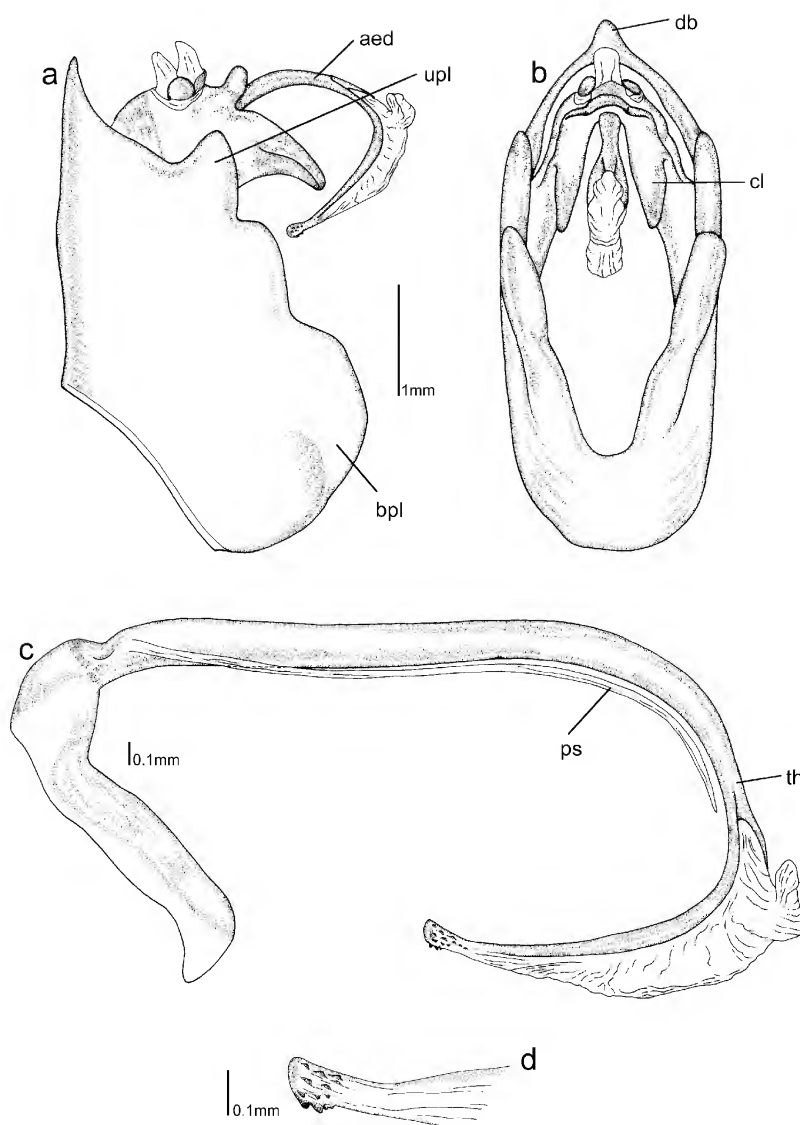
In the original description, Distant (1892) gives the type locality as Victoria and the collector as Stephen Barton. The type series is described as being located in the Australian Museum, Tasmanian Museum and in Distant’s private collection; however, the only specimens that could be located from the original syntype series are two females located in the NHM (which presumably originated from Distant’s private collection). There are two male specimens in the AM from Victoria that have originated from J. H. Ashton’s private collection (donated in 1911; *pers. comm.* Derek Smith, Collection Manager, Australian Museum, 13 December 2016). These specimens do not form part of the type series of *Y. abdominalis*. They belong to a different species (*Y. spectabilis* sp. nov.) and are listed under the material for that species.

**Material examined.** VICTORIA: *Syntypes*: 2 females, [handwritten] “*abdominalis* Distant” / [typeset] “Victoria, Barton”, “Distant Coll. 1911—383” / [round label, red border] “Type” / [round label, blue border] “syntype”, [no collection date] (NHM). 2♂♂, Victoria, H. Ashton collection, AM K.307107–08; 1♀, Mt. Cobungra, VIC, xii.1933, A. Musgrave (AM); 1♀, Apollo Bay, Victoria, W. W. Froggatt collection (ANIC); 2♂♂, Morwell National Park, 38°21'50"S 146°24'58"E, 2.i.2004, 223 m, K. Harris, *E. globulus*, 517-0001, 517-0002; 1♂ Blanket Bay, Otway Ranges, 38°39'43"S 143°34'59"E, found dead, 13.xii.2004, L. W. Popple, 517-0003 (LWP); 11♂♂, nr Pittong, 38 km WSW of Ballarat, 4.xii.2006, 37°40'787"S 143°30'615"E, 358 m [elev.], D. Marshall, K. Hill, AU.VI.BAX; 1♂, same data, C. Simon lab voucher, legs in ETOH, body pinned, “Yoyetta golden peeper”, specimens recorded, 06.AU.VI.BAX.01; 1♂, same data, 06.AU.VI.BAX.02; 1♂, Grampians National Park Visitor’s Centre, 37°09'508"S 142°31'699"E, 237 m [elev.], 1.xii.2006, D. Marshall, K. Hill, AU.VI.GVC, C. Simon lab voucher, legs in ETOH, body pinned, “Yoyetta Grampians abdominalis”, specimens recorded, 06.AU.VI.GVC.02; 1♂, same data, 06.AU.VI.GVC.01; 1♂ 1♀, AU.VI.TOW, Rest area on B440, approx. 3 km W of Toora, 38°39'20"S 146°17'50"E, 25m, 5.xii.2006, D. Marshall, K. Hill; 2♂♂, Upper Mitta Mitta River, Glen Valley, 28.xii.1994, M. S. & B. J. Moulds; 1♂ 1♀, Starvation Ck Rd, nr O’Shannessy Dam, 9.xii.2007, Stephen Smith; 1♀, U. Flat Rock Ck, 6.ii.1959, R. May (MSM); 7♂♂ 2♀♀, Regional Park, Seville, 37°46'52"S 145°27'47"E, 15.xii.2018, S. Emery & T. Corbin (DE); 1♂ 1♀, same location, 15.xii.2018, S. Emery & T. Corbin (HEM 5759[♀], 5760[♂]) (MMV). TASMANIA: 1♀, Liffey Valley Tas, 4.i.1983, S. Fearn (ANIC); 4♂♂ 1♀, “Elderslie”, Petham Farm, TAS, 29.xii.1998, G. Davis; 2♀♀, Broadmarsh, TAS, 20.i.2002, G. Davis; 9♂♂ 2♀♀, same location, 18.xii.2004, G. Davis; 1♂ 1♀, South Cape Range, TAS, 390m, 43°58'39"S 146°34'76"E, 10–15.xii.2011, G. Bretschneider; 8♂♂ 1♀, Carriage Rd, Hobart, TAS, 42°52'14"S 147°19'39"E, 18–19.xii.2012, N. & D. Emery; 2♂♂ 1♀, Adventure Bay, Bruney Is., TAS, 43°12'35"S 147°21'32"E, 19.xii.2012, T. N., S., C. & D. Emery; 4♂♂ 6♀♀, Rocky Hill, 42°23'11"S 148°02'07"E, 12.xii.15, S. Emery & T. Corbin (DE); 1♀, Wedge Bay, TAS, 28.i.1913, G. H. Hardy; 1♀, same location, 5.i.1914, G. H. Hardy; 1♂, same location, 25.xii.1913, G. H. Hardy (AM); 1♂, Marion Bay, TAS, 15.xii.1937, Tas. Biological Survey (F5707); 4♂♂, Wedge Bay, TAS, 28.xii.1913, G. Hardy (F5709-12); 1♀, Tarroona, TAS, 10.i.1945, JRC (F5676); 4♂♂ 3♀♀, Bracknell, TAS, 17.i.2007, R. Bashford (F28991-97); 3♂♂, same location, 16.i.2008, R. Bashford (F28998–29000); 4♂♂ 1♀, same location, 14.i.2009, R. Bashford (F29001–005); 4♂♂, Bell Bay, TAS, 4.i.2007, R. Bashford (F29012 015); 2♀♀, same location, 24.xii.2007, R. Bashford (F29016 017); 7♂♂, Jetsonville, TAS, 5.i–15.ii.2009, R. Bashford





**Figure 15.** *Yoyetta abdominalis* (Distant) (*A*) male Broadmarsh (42°40'S 147°09'E), dorsal habitus; (*B*) male, ventral habitus; (*C*) male, Wandilo, (37°42'S 140°41'E), dorsal habitus; (*D*) male, Wandilo, ventral habitus; (*E*), female, Broadmarsh (42°40'S 147°09'E), dorsal habitus; (*F*), female, ventral habitus; (*G*), female syntype, [no location] NHM (photo Ken Merrifield); (*H*), female, live specimen Lilydale (41°14'S 147°12'E; photo Charlie Price). Scale bars as indicated.

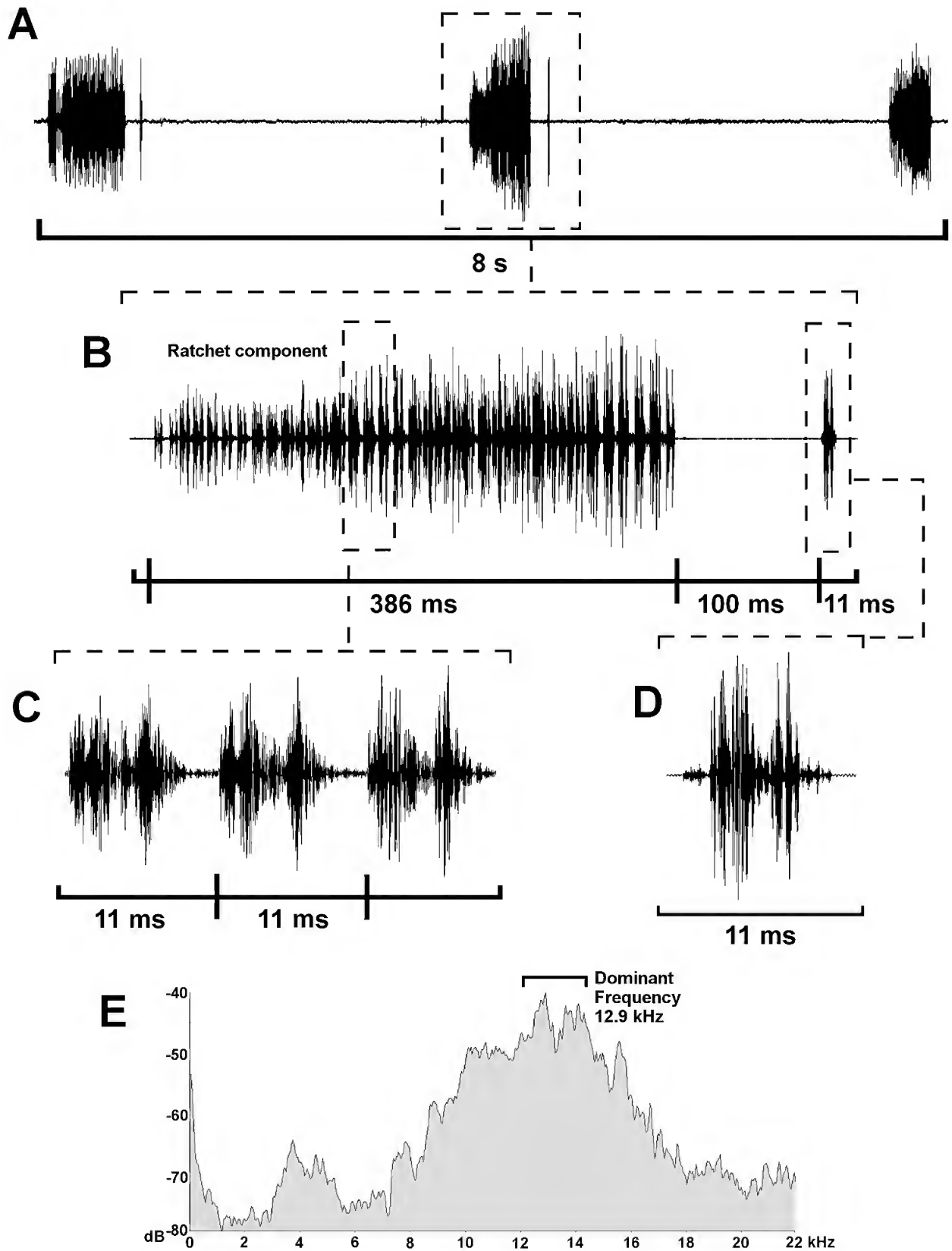


**Figure 16.** *Yoyetta abdominalis* (Distant): illustration of male pygofer and internal genitalia; (a) viewed laterally from the left; (b) viewed ventrally; (c) aedeagus; and (d) apex of theca. Characters as depicted in Fig. 4. Specimen from Hobart (42°52'S 147°19'E).

(F29019–024); 2♂♂, Retreat, TAS, 17.i.2007, R. Bashford, (F29028 029); 1♂, Lefroy, TAS, 20.xii.2006, R. Bashford, (F29030) (TMAG); 2♂♂, 3♀♀, Pelham, 29.xii.1998, G. Davis; 2♂♂, Rd Jct., 4 km NE of Gladstone, 7.ii.1992, M. S. Moulds; 1♂, Mt Nelson, 16.i.1982, R. B. McQuillan; 1♀, Mt Field Nat. Pk, 13.i.1995, David Cowie; 1♂, Browns Bridge Rd, 2.3 km NE of Gladstone, 40°56.930'S 148°01.638'E, 47 m [elev.], 24.i.2011, K. Hill, D. Marshall, AU.TAS.GLE, C. Simon lab voucher, legs in ETOH, body pinned, Yoyetta “Tasmanian golden peeper”, song heard, 11.AU.TS.GLE; 1♂, Fossil Bluff, NW of Wynyard, off Freestone Cres., 40°58.811'S 145°43.797'E, 20 m [elev.], 19.i.2011, K. Hill, D. Marshall, C. Simon lab voucher, legs in ETOH, body pinned, Yoyetta “Tas. golden peeper”, specimen rec., 11.AU.TS.FOS.07; 1♂, same data, 11.AU.TS.FOS.06; 1♂, c. 6 km SSE of St Helens on Tasman Hwy, 41°22.180'S 148°16.456'E, 17 m [elev.], 24.i.2011, K. Hill, D. Marshall, AU.TS.SHS, C. Simon lab voucher, legs in ETOH, body pinned, Yoyetta “Tasmanian golden peeper”, song heard, 11.AU.TS.SHS (MSM); 2♂♂, Carriage Rd, Hobart, TAS, 42°52.141'S 147°19.385'E, 18–19.xii.2012, N. & D. Emery, 517-0008, 517-0009; 2♂♂ 2♀♀, “Elderslie”, Petham Farm, TAS, 29.xii.1998, G. Davis (LWP); 4♂♂ 4♀♀, Devonport, Tas, Lea, SAMA Database No. 20-014454 to 20-014461; 1♂ 1♀, G. H. Hardy, Wedge Bay, 29.xii.1913, SAMA Database No. 20-014462, 20-014463; 1♀, G. H. Hardy, Wedge Bay, 5.i.1994, *Melampsalta abdominalis* Dist., SAMA Database No. 20-014464 (SAM). NEW SOUTH WALES: 1♂, Alpine Creek, 7 mls SE of Kiandra, NSW, 25.i.1967, T. G. Campbell (ANIC); 3♂♂ 1♀, 5 km W Nimmitabel, NSW, 36°31'16"S 149°14'08"E, 30.xii.2009, L. W. Popple, 517-0004 to 517-0007 (LWP); 2♀♀, Swampy Plains R., near Geehi,

Snowy Mts, 29.xii.1979, P. S. Valentine; 1♀, Thredbo Diggings, Kosciusko Nat. Pk, 3.i.1980, P. S. Valentine; 1♂, Geehi, headwater of Murray River, Kosciusko Nat. Pk, 27.xii.1994, M. S. & B. J. Moulds; 2♂♂ 1♀, Mt David, 30 km SW of Oberon, 26.xii.1985, S. & B. Underwood; 1♂, Yarrangobilly Caves road, Kosciusko NP, 35°33.258'S 148°30.842'E, 17.i.2011, 1305 m [elev.], K. Hill, D. Marshall, AU.NS.YAX, C. Simon lab voucher, legs in ETOH, body pinned, Yoyetta “high pitched 2”, specimen recorded, 11.AU.NS.YAX.02; 1♂, same data as previous, 11.AU.NS.YAX.03 (MSM). SOUTH AUSTRALIA: 1♂, Millicent, SA, 2.i.2004, B. Haywood; 2♂♂, Wandilo, SA, 37°42'05"S 140°41'25"E, 1–5.ii.2013, B. Haywood (DE); 1♂, *Melampsalta prolongata* G. & F., Mt Muirhead, A. G. Edquist, 4.i.[19]10, SAMA Database no. 20014441 (SAM); 1♂, Whennan Cons. Zone, 37°33'53"S 140°31'08"E, in red gum swamp (mating), B. T. Haywood, 12.i.2012, 517-0010; 1♂, Wandilo, SA, 37°42'05"S 140°41'25"E, 5.ii.2013, Swamp gum over woodland B. T. Haywood, 517-0011 (LWP); 1♂, The Marshes Native Forest Reserve, E of Millicent, 37°36.908'S 140°31.314'E, 84 m [elev.], 2.xii.2006, K. Hill, D. Marshall, B. Haywood, AU.SA.MAR, C. Simon lab voucher, legs in ETOH, body pinned, “Yoyetta tea tree firetail”, specimen recorded, 11.AU.SA.MAR.01 (MSM).

**Distribution, habitat and seasonality.** Cool temperate locations in southern New South Wales, the Australian Capital Territory, Victoria, Tasmania and southeastern South Australia (Fig. 18). Adults occur on eucalypts, including



**Figure 17.** Male calling song structure of *Yoyetta abdominalis* (Distant) illustrated in waveform plots, including (A) three separate phrases; (B) expanded section (from A) showing a single phrase, which is composed of a long echeme followed by a syllable; (C) further expanded detail of the long echeme (from B); (D) further expanded detail of the syllable (from B). The final subfigure (E) is a spectrogram displaying song frequency. The specimen was recorded in the field at Nimmitabel (36°31'S 149°14'E) by LWP using RS2 (see *Methods and terminology*).

*Eucalyptus ovata*, often on the upper branches, but also on low shrubs, particularly after eclosion. This species can be encountered from December to February.

### Description

**Male** (Figs 15A–D, 52F). Mainland specimens, particularly those from South Australia, often exhibit paler coloration (Fig. 15C,D), than the predominantly dark brown to black and orange-red markings of Tasmanian (island) specimens (Fig. 15A,B).

**Head** not quite as wide as mesonotum, conspicuous golden pubescence; mainly black on island specimens, with a small, triangular brown fascia posterior to ocelli, reducing anteriorly, small to large ochraceous spot on posterior margin between ocelli and eye. Head colour ranges from mainly black to predominantly pale brown-ochraceous, black surrounding ocelli; ocelli pink to orange-yellow; postclypeus dorsally dark brown to black with yellowish triangular median fascia, apex directed anteriorly, ventral surface black with black transverse grooves, midline ochraceous anteriorly in some specimens, lateral and posterior borders ochraceous; anteclypeus dark brown on island specimens, on mainland cicadas ochraceous with a central black line or small black spot on posterior segment; rostrum black at base, dark brown centrally, black at apex, reaching anterior edge of hind coxae; lora dull black to ochraceous; eyes variably dull black to dark brown; antennae black; supra-antennal plates black, with central brown spot on anterior margin extending laterally above pedicel.

**Thorax** predominantly dull black with conspicuous golden pubescence. Pronotum black with distinct ochraceous marking over central third of midline, expanding laterally on some mainland cicadas posterior to fissures, covering central half of pronotal collar, central black spot on posterior margin of pronotum; pronotal collar black in island specimens, anterior margin black, dark brown to black posteriorly on mainland specimens. Mesonotum black in island cicadas; cruciform elevation black, lateral depressions yellow; submedian and lateral sigilla black to pale brown on mainland specimens, remainder of mesonotum ochraceous, some blackening posteriorly around midline; scutal depressions black, cruciform elevation black to ochraceous. Metanotum black on island cicadas, posterior margin ochraceous around timbal cavity; metanotum ochraceous on mainland cicadas, with pinkish anterior margin centrally, blackening towards lateral margins, pink posterior border around timbals.

**Legs.** Coxae mainly ochraceous, with lateral black markings ranging from proximal spot to a longitudinal stripe, membranes red; trochanter black, striped ochraceous on mainland specimens; meracantha small, narrow, white, black at base, pointed, overlapping one-third of opercula; fore femora with outer side red, variable longitudinal black stripes, inner side variably black-ochraceous, ochraceous to black at joints; femoral spines erect, black at base tending brown at tips; fore tibiae black in Tasmanian specimens, mainly ochraceous on mainland cicadas; mid and hind tibiae striped black and ochraceous on Tasmanian specimens, paler on mainland cicadas; Fore tarsi dark brown to claws, mid tarsi light brown with black at claws, hind tarsi ochraceous to claws, claws brown, black at tips, mainland species with

tarsi pale, brown towards claws, claws brown, black at tips.

**Wings** with fore wing costal veins orange-brown proximally, becoming red distally; pterostigma mottled red; basal cell transparent with a black anterior border; basal membranes pale orange, orange or pink; vein CuP +1A whitish over proximal half, pale brown distally; other veins dark brown to black; with eight apical cells. Hind wing plagas white over entire anal cell 3 and thin along vein 2A, some orange stippling on proximal third; with six apical cells.

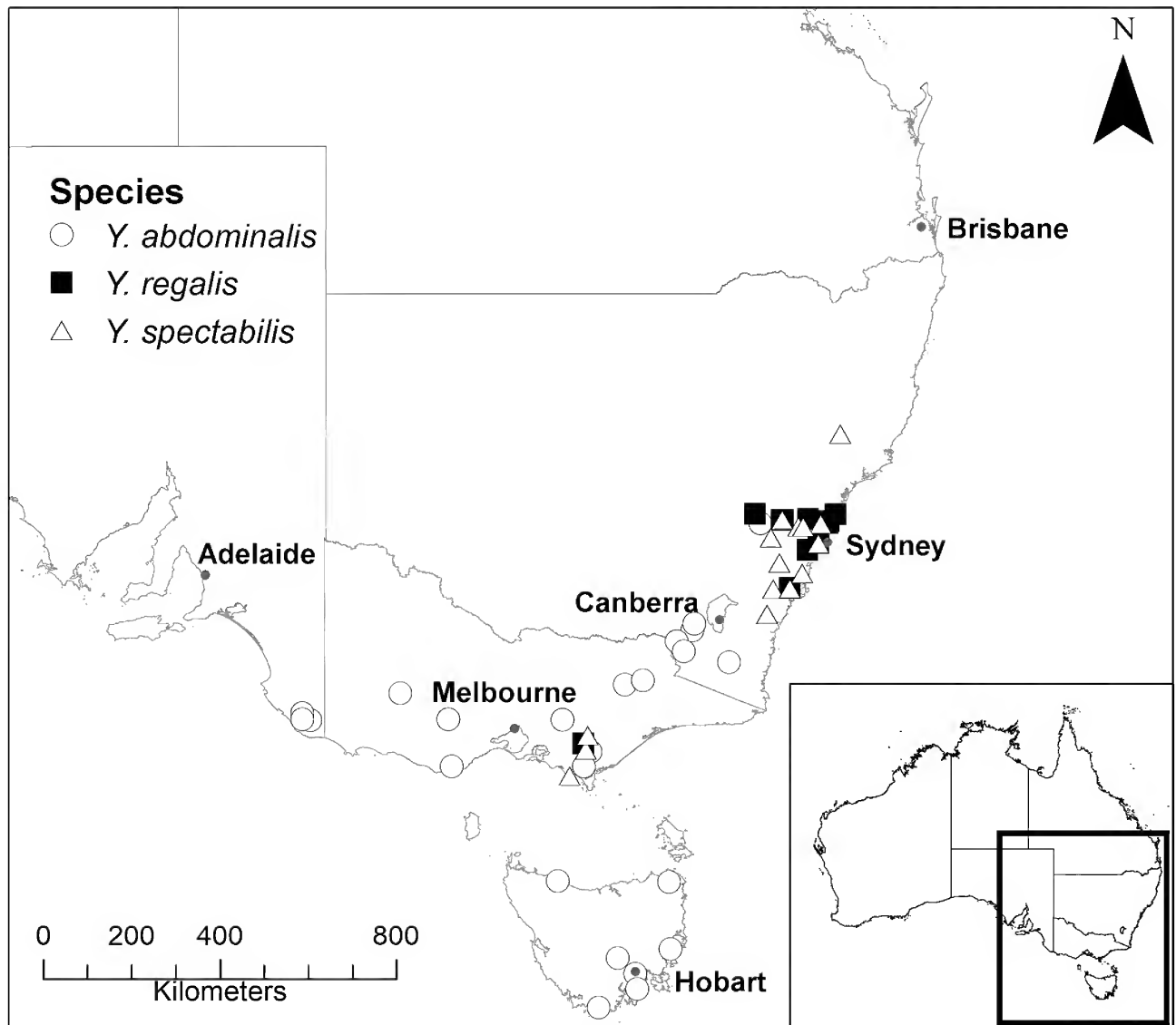
**Opercula** (Fig. 3G) small, spatulate, following body axis ventrolaterally, depressed centrally; small black mark at base, contrastingly pale cream across remainder, with reddish tinge centrally on mainland specimens; clearly separated.

**Timbals** (Fig. 2G) with five distinct long ribs; long ribs 1–4 extending across surrounding membrane and fused dorsally along basal spur; long rib 5 independent of basal spur, comparatively shorter, extending ventrally across half of membrane; large ridged dome on posterior timbal plate extending across two-thirds of timbal; apodeme pit oval-shaped and conspicuous.

**Abdomen** with tergite 1 black in island specimens, with faint orange margins over timbal cavity; tergite 1 ochraceous to black on mainland cicadas, pink anterior margin extending across timbal cavity, with black marking over lateral region of timbal; tergite 2–3 on all specimens ochraceous centrally with reddish-orange intersegmental membrane, several small black spots in a transverse arc across middle, variably black over lateral region; tergites 4–7 black with posterior margins ochraceous, an increasing area of lateral orange coloration posteriorly forming a triangular shape with base at tergite 7; extending to lateral border and epipleurite 7, several black spots in orange areas on some specimens; tergite 8 shiny black anteriorly and variably over central midline, orange-red laterally over posterior region. Epipleurites 3–6 with black medial markings, orange posteriorly; epipleurites 3–5 ochraceous on lateral extremities. Sternite II mainly black, reddish margins around timbals; sternite III black, posterior margin ochraceous; sternites IV–VI mainly orange, black midline markings over anterior two-thirds of each sternite, decreasing posteriorly; sternite VI orange with red posterior margin; sternite VIII fiery red, with golden pubescence.

**Genitalia** (Fig. 16). Pygofer black dorsally, reddish posteriorly, becoming brown laterally; dorsal beak brown, anal styles bright red; upper lobe mainly black, red at tip; basal lobe dark ochraceous to black. Uncus orange-brown; in lateral view beak-like and rounded ventrally; lobes in ventral view bulbous, with rounded lateral termination, completely surrounding posterior aspect of claspers; claspers dark brown, clearly divided, with apices gradually tapering laterally. Aedeagus with pseudoparameres extending more than half-way to the flexure of the theca; theca recurved ventrally at 180° towards apex, with transparent flanges along dorsal margin of recurvature, these mainly smooth and broadening to > 3× width of theca ventrally, without dorsal ornamentation; apex short, sclerotized, transparent, stumpy, with prominent cornuti over lateral and ventral surface, “scoop-shaped” ventrally.

**Female** (Fig. 15E–H). **Head** and **thorax** similar to male, with distinctive morphological patterns consistent on island and mainland specimens.



**Figure 18.** Map of southeastern mainland Australia showing the geographical distribution of *Yoyetta regalis* sp. nov. (closed squares), *Y. abdominalis* (Distant) (open circles) and *Y. spectabilis* sp. nov. (open triangles).

**Abdomen** markings on tergites and sternites, respectively, similar to island and mainland males, sternites becoming more orange or red posteriorly; abdominal segment 9 black above with orange longitudinal stripes either side of midline, curving anteriorly and becoming orange to red laterally and ventrally, dorsal beak black. Ovipositor brown, tending darker towards apex, not extending beyond apex of abdominal segment 9. Anal styles bright red; ovipositor sheath brown to black.

**Measurements** (in mm; range with mean in parentheses: 24 males, 12 females). Body length: male 19.2–21.7 (20.8); female 20.5–24.0 (21.9). Fore wing length: male 20.3–24.8 (23.5); female 23.5–26.9 (25.3). Head width: male 5.7–6.6 (6.1); female 6.2–6.8 (6.4). Pronotum width: male 5.3–6.1 (5.7); female 6.2–6.6 (6.3). Abdomen width: male 5.7–6.1 (6.0); female 5.7–6.8 (6.3). Ovipositor length 5.2–6.1 (5.7).

**Distinguishing features.** *Yoyetta abdominalis* is readily distinguished from *Y. hunterorum*, *Y. denisoni*, *Y. kershawi* stat. rev., comb. nov. *Y. timothyi* sp. nov., *Y. regalis* sp. nov., *Y. subalpina* sp. nov. and *Y. aede* by the following

combination of characters: (1) smaller size with body length < 23 mm, (2) presence of symmetrical, orange triangular patterns on tergites 4–7, (3) ovipositors of females do not extend beyond the posterior abdomen. Specimens are larger than *Y. electrica* sp. nov. (BL < 18 mm) and both species reside in different geographical locations. Tasmanian (island) specimens of *Y. abdominalis* are often more hirsute and paler than *Y. spectabilis* sp. nov. and *Y. serrata* sp. nov., but some mainland specimens closely resemble these 2 species. The following combination of characters can be used to separate *Y. abdominalis*, *Y. serrata* sp. nov. and *Y. spectabilis* sp. nov.: (1), the longitudinal central marking on the pronotum of *Y. abdominalis* and *Y. serrata* sp. nov., is absent from *Y. spectabilis* sp. nov. except on brown coloured females; (2), the bright red coloration over the posterior half of the opercula of *Y. spectabilis* sp. nov. contrasts with the dull red-brown coloration on specimens of *Y. serrata* sp. nov. and black to pale brown marking on *Y. abdominalis*; (3), the forewing costa and basal membrane of *Y. abdominalis* and *Y. serrata* sp. nov. are orange to pale yellow-white and grey, respectively, cf. bright orange-red in *Y. spectabilis* sp. nov.;

(4) epipleurites of *Y. abdominalis* and *Y. serrata* sp. nov. are orange and black, whereas those of *Y. spectabilis* sp. nov. are red and black; (5) cornuti are restricted to the ventral surface of the thecal apex of *Y. serrata* sp. nov., whereas they are prominent over the entire apex of both *Y. abdominalis* and *Y. spectabilis* sp. nov.; (6) timbal long rib 4 of *Y. spectabilis* sp. nov. is discontinuous over its medial third, whereas in both *Y. abdominalis* and *Y. serrata* sp. nov. long rib 4 spans the length of the membrane and remains unbroken.

**Calling song** (Figs 17, 53I). The call of *Y. abdominalis* consists of repeated phrases with a long ratchet-like echeme often preceded by one or more syllables or short macrosyllables (e.g., Fig. 17). Based on the recordings from Nimmitabel ( $n = 7$ ), the long echeme comprises a series of 24–50 macrosyllables (each 0.005–0.012 s duration) that lasts 0.201–0.499 s. In phrases, where (macro)syllables (0.010–0.015 s duration) are produced, a gap of 0.078–0.100 s duration occurs before the (macro)syllable. Males do not appear to call at regular intervals except when phrases include the (macro)syllable. Following the macrosyllable, a gap of approximately 2 s occurs at the end of each phrase. The highest frequency plateau from available recordings is fairly broad, between 7.7 and 16.2 kHz, with a dominant frequency of 10.2–14.1 kHz.

The calling song of *Y. abdominalis* is distinctive and unlike other species in the genus. It bears a superficial resemblance to *Y. fluviatilis* Emery, Emery & Popple. However, close inspection reveals that each phrase of *Y. fluviatilis* begins with a syllable sequence rather than a long echeme. The song of *Y. abdominalis* also has broad similarities with *Y. subalpina* sp. nov. and differences are discussed under that species.

### *Yoyetta regalis* sp. nov.

<http://zoobank.org/NomenclaturalActs/2428C6E9-758A-4D71-8B4A-AD0233415B46>

Figs 2C, 3C, 18–21, 52C, 53L

*Cicadaetta* sp. nr *abdominalis* (“Red ringer”).—Emery *et al.*, 2005: 99, Fig. 6.

**Holotype** ♂, Wises Track, Royal National Park, NSW, 34°06'59"S 151°03'30"E, 25.i.2004, S. & D. Emery (AM K.536051). **Paratypes** NEW SOUTH WALES: 1♂, Hartley Vale, 30.xii.1971, S. G. Watkins, donated 2001; 1♂, same data, 7.i.1972; 1♂, NSW, Blue Mtns, G. Burns, 1905 (ANIC); 1♂, Ingleside, NSW, 33°40'17"S 151°15'14"E, 20.xii.1994, D. Emery; 1♂, Cataract Dam, NSW, 34°14'39"S 150°49'18"E, 8.xi.1995, D. Emery; 1♂ 1♀, Kinka Reserve, Terrey Hills, NSW, 33°40'39"S 151°12'00"E, 16.i.1997, D. Emery; 7♂♂, Booralie Rd, Terrey Hills, NSW, 33°40'34"S 151°12'52"E, 8.i.2004, S. & D. Emery; 1♂, Wises Track, Royal National Park, NSW, 34°06'59"S 151°03'30"E, 13.i.2006, N. & D. Emery; 3♂♂, same location, 1–20.i.1998, D. Emery; 1♀, same location, 8.i.2002, S., N. & D. Emery (DE); 1♂, Wentworth Falls, NSW, 21.xii.1923, Harrison; 1♂, Jenolan, NSW, 7.xii.1929, CRW; 1♂ 1♀, Monaro, NSW (no name or date); 1♂, Cooma, NSW (no name or date); 2♂♂, Buffalo, Vic., i.1937, K. S. W. Sutton (McM); 1♂, Bendalong, NSW, 8.i.1969, G. Daniels; 1♂, Sydney, NSW, 22.i.1953, H. Hughes; 1♂, Goondara Range, Royal National Park, NSW, 13.xii.1969, G. Daniels (AM); 2♂♂ 1♀, Kuringai Chase National Park, 8.i.2004, S., N. & D. Emery; 1♂, Wises Track, Audley, 30.xi–1.xii.2003, L. Popple, D. Emery, 512-0001; 1♀, same location as previous, 5.i.2004, S., N. & D. Emery; 1♀, same location as previous, 24.i.2004, S. & D. Emery; 1♂, Hat Hill Rd, Blackheath, 22.xii.2002, S., N. & D. Emery; 1♂, Wambool Nature Reserve, 33°29'43"S 149°45'41"E, open woodland, 8.i.2010, Popple & Emery, 5120-0002; 1♂, Blackheath, i.2010, D. Emery, 512; 1♂, Pulpit Rock via Blackheath, 33.619265°S 150.327337°E, xii.2009, D. Emery, 512 (LWP); 1♂, Curra Moors T[rac]k, R[oyal] Nat. Pk, 13.i.2004, J. R. W.; 4♂♂, Menai 2.i.[19]79, R. Eastwood; 1♂, Forestville, Sydney, 12.ii.1975, C. Holmes; 1♂, West Head, 20.i.1970, A. B. Rose; 1♂, Nellie's Glen, Blue Mountains, 30.xii.1978, L. R. Ring; 1♂, nr Native Dog

Hill, 38 km E of Rylestone, 30.xii.1977, G. Daniels; 1♂, Mt Keira, 27.xi.1994, R. de Keyser & A. Sundholm; 1♂, Gonarra Ridge, Royal National Park, 29.i.1979, G. Daniels; 1♂, AVALON, 5.XII.[19]57; 1♀, Hat Hill, Blackheath, 30.xi.1975, G. Daniels; 1♂, 75/203 Fairburn Rd, Wedderburn, S. of Sydney, 34°09.009'S 150°49.789'E, 135 m [elev.], 21.xi.2006, K. Hill, D. Marshall, D. & T. Britton, C. Simon lab Voucher, legs in ETOH, body pinned, 06.AU. NS.BRI.01, “Yoyetta red ringer”, specimen recorded (MSM); 1♀, Moe, Vic, 38°11'S 146°16'E, 26.ii.1891 (HEM2327) (MMV).

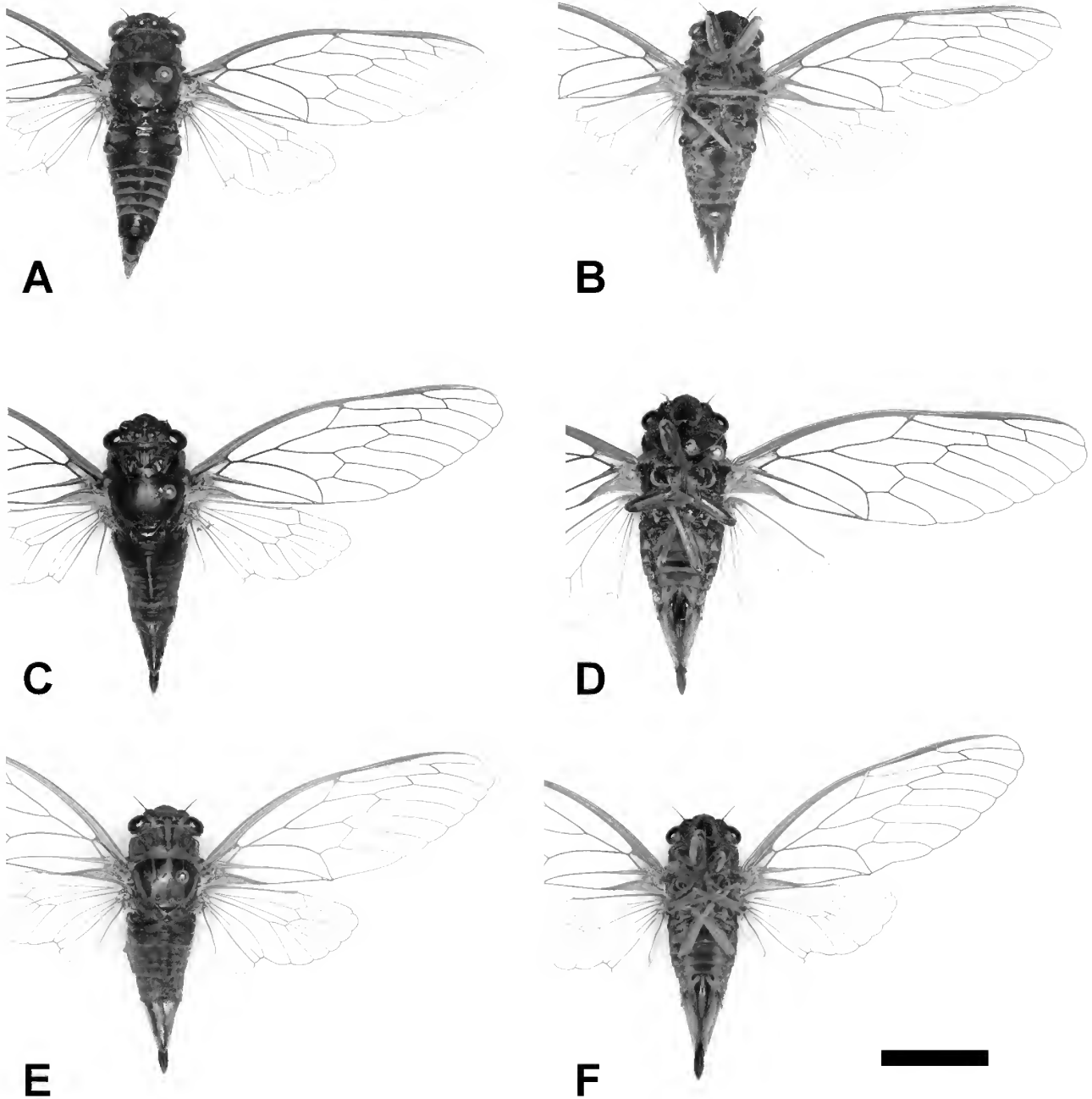
**Other material.** NEW SOUTH WALES: 2♂♂, Wises Track, Royal National Park, NSW, 34°06'59"S 151°03'30"E, 22.xii.2002, S., N. & D. Emery; 2♂♂, same location, 17.ii.2005, S. & D. Emery; 4♂♂ 1♀, same location, 1.i.2006, S. & D. Emery; 1♀, same location 22.i.2007, N. & D. Emery; 5♂♂ 1♀, same location, 29.xi.2003, N. & D. Emery & L. Popple; 2♂♂ 3♀♀, same location, 5.i–5.ii.2004, S., N. & D. Emery; 13♂♂, 3♀♀, same location, 5–25.i.2004, S., N. & D. Emery; 1♀, Hat Hill Rd, Blackheath, NSW, 33°36'59"S 150°18'29"E, 14.xii.2002, D. Emery; 6♂♂ 1♀, same location, 15.xi.09, N. & D. Emery; 2♀♀, same location, 6.xii.2009, D. Emery; 1♂, Waterfall, NSW, 21.xi.2006, R. Chin; 1♀, Capertee, NSW, 33°08'25"S 149°58'47"E, 9.xii.2009, D. Emery; 1♂, 4 km N Wambool Nature Reserve, NSW, 8.i.2010, D. Emery & L. Popple; 5♂♂ 1♀, Anvil Rock, NSW, 33°35'44"S 150°50'19"E 12–16.xii.2012, N. & D. Emery; 7♂♂, Lockley's Pylon track, Leura, NSW, 33°36'05"S 150°20'00"E, 16.xii.2012, N. & D. Emery; 1♂, Boodi National Park, NSW, 33°30'41"S 151°24'03"E, 100 m, 24.xi.[20]13, N. Emery; 1♂, same location, 5.1.14, N. Emery; 4♂♂, Anvil Rock, Blackheath, NSW, 33°35'44"S 150°50'19"E, 971 m, 4.xii.14, D. & C. Emery; 1♂ 1♀, Wentworth Falls, NSW, 820 m, 4.xii.[20]14, D. & C. Emery; 1♀, Evans Lookout, Blackheath, NSW, 33°06'60"S 150°18'29"E, 5.xii.[20]14, C. & D. Emery; 2♂♂, 15 km SW Nowra, NSW, 35°00'35"S 150°28'37"E, 280m, 1.i.[20]15, S., N., C. & D. Emery; 1♂, Towlers track, Kuringai-Chase National Park., NSW, 33°37'33"S 151°16'39"E, 8.i.[20]15, D. Emery (DE).

**Distribution, habitat and seasonality.** Occurring within central New South Wales from Brisbane Waters and Royal National Parks west to Wambool Nature Reserve near Bathurst and south to around Nowra, with isolated old specimens collected from eastern Victoria (Fig. 18). Males occur mainly on the trunks and upper branches of smooth-barked eucalypts. Populations may be sympatric but are generally not syntopic with *Y. spectabilis* sp. nov., which prefers the tops of shrubs in open woodland. However, in open woodland, females of *Y. regalis* sp. nov. may also be located close to the ground on woody shrubs. They can be encountered from late November to January.

### Description

**Male** (Figs 2C, 3C, 19A,B, 52C). *Head* almost as wide as mesonotum, mainly black, with an ochraceous central triangular marking posterior to ocelli, widest at posterior margin, reducing anteriorly, and a second small ochraceous spot between ocelli and eye in some specimens; ocelli pink to pale red; dorsal postclypeus black centrally, dark brown laterally, ventral surface black with black transverse grooves, lateral and posterior borders ochraceous; anteclypeus black, rostrum black at base, dark brown centrally, black at apex, reaching anterior margins of hind coxae; lora black with ochraceous lateral margin, gena black; eyes dull black; antennae black, supra-antennal plates black, reddish area at junction with pedicels.

*Thorax* mainly dull black with variable brown patterning. Pronotum black, lateral half or anterior margin brown, with a thin central brown line tapering and not reaching anterior or posterior margins, brown with patchy black markings over raised lateral areas of pronotum, fissures mainly black; pronotal collar black, posterior margin brown, margins of lateral angles brown, paranota black with anterior angles brown. Mesonotum black with dark brown coloration between sigella in some specimens, parapsidal suture dark brown,



**Figure 19.** *Yoyetta regalis* sp. nov., (A) male holotype, Royal National Park (34°06'S 151°03'E), dorsal habitus; (B) male, ventral habitus; (C) female, dark specimen, Royal National Park dorsal habitus; (D) female, dark specimen, ventral habitus; (E), female, lighter specimen, Royal National Park, dorsal habitus; (F) female, lighter specimen, Royal National Park, ventral habitus. Scale bar = 10 mm.

scutal depressions and surrounds black; cruciform elevation arms black, lateral depressions brown. Metanotum black.

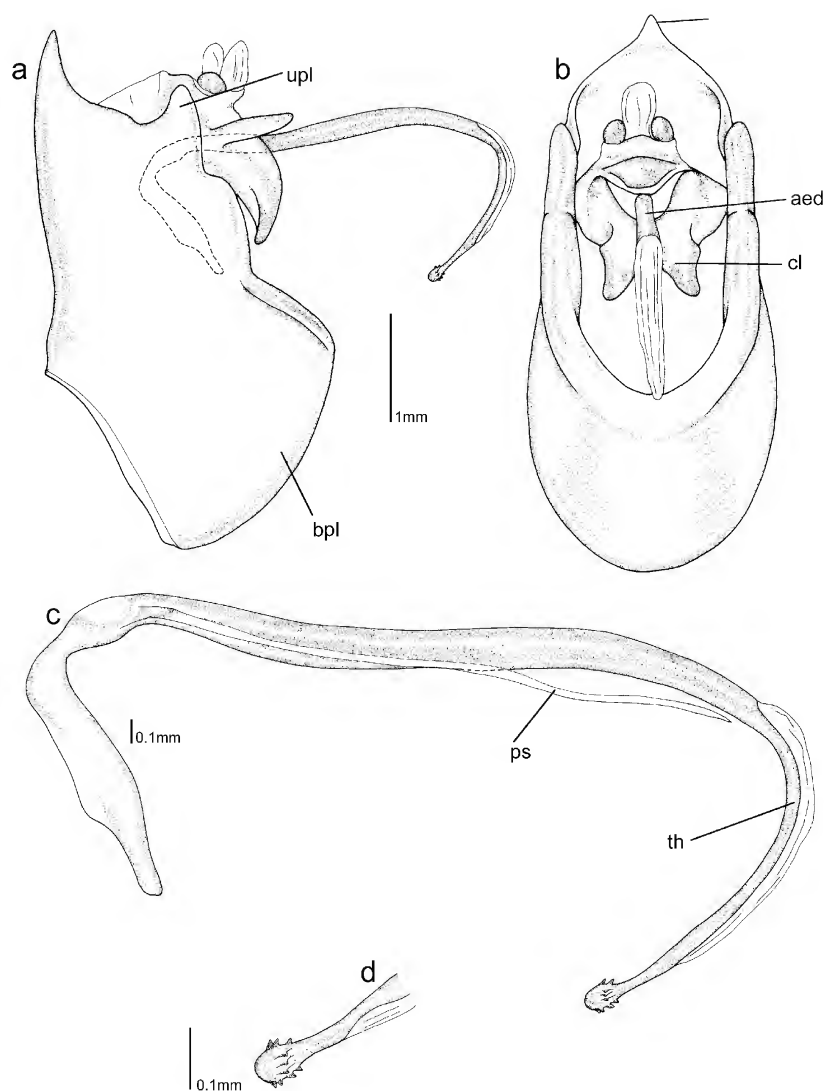
**Legs.** Coxae mainly black, fore coxae black anteriorly, reddish-brown posteriorly with a black lateral stripe, mid and hind coxae black, coxal membranes red, basisterna black; meracantha small, narrow, orange, black at base, pointed, overlapping one-third of opercula; trochanters orange-red with black medial stripe; fore femora with lateral and posterior areas red, black medially and around base of femoral spines; femoral spines erect, reddish to black at base tending dark brown at tips, mid and hind femora black anteriorly, remainder orange-brown, with variable black stripe laterally, distal femoral joints orange-red; tibiae black proximally,

tending brown towards tarsi; tarsi reddish-brown becoming black towards claws; claws dark brown, black at tips.

**Wings** with fore wing costal veins orange-brown, darker central rib; pterostigma mottled red; basal cell yellow-brown to translucent with black anterior border; basal membranes bright orange; other veins dark brown to black, with eight apical cells; hind wing plagas white along margins of anal cell 3 and vein 2A, central area of jugum variably clear, clear posteriorly, some reddish stippling at base, with six apical cells.

**Opercula** (Fig. 3C) medium, spatulate, following body axis ventrolaterally, depressed centrally, variably black over basal





**Figure 20.** *Yoyetta regalis* sp. nov., illustration of male pygofer and internal genitalia; (a) viewed laterally from the left; (b) viewed ventrally; (c) aedeagus; and (d) apex of theca. Characters as depicted in Fig. 4. Specimen from Blackheath (33°35'S 150°50'E).

half, orange across remainder, clearly separated.

**Timbals** (Fig. 2C) with five distinct long ribs; long ribs 1–3 extending across surrounding membrane and fused dorsally along basal spur; long rib 4 unfused to basal spur; long rib 5 independent of basal spur, comparatively shorter, extending ventrally across half of membrane; prominent intercalary rib between long ribs 3 and 4; large ridged dome on posterior timbal plate extending across two-thirds of timbal; apodeme pit oval-shaped and conspicuous.

**Abdomen** with tergite 1 black with brown-ochraceous border around timbal cavity; tergite 2 black; tergites 3–7 black with orange posterior margins, extending laterally to epipleurites, increasing anteriorly on tergites 6–7 on either side of midline; tergite 8 shiny black, with variable brown lateral markings. Epipleurites with medial black strip, orange over remainder. Sternite II mainly black, central ochraceous spot; sternite III black medially, orange-red over central third posterior to timbal cavity, black laterally; sternites IV–VI orange, posterior halves becoming progressively reddish, black midline markings over anterior two-thirds of each sternite, decreasing posteriorly; sternite VIII orange brown, faint

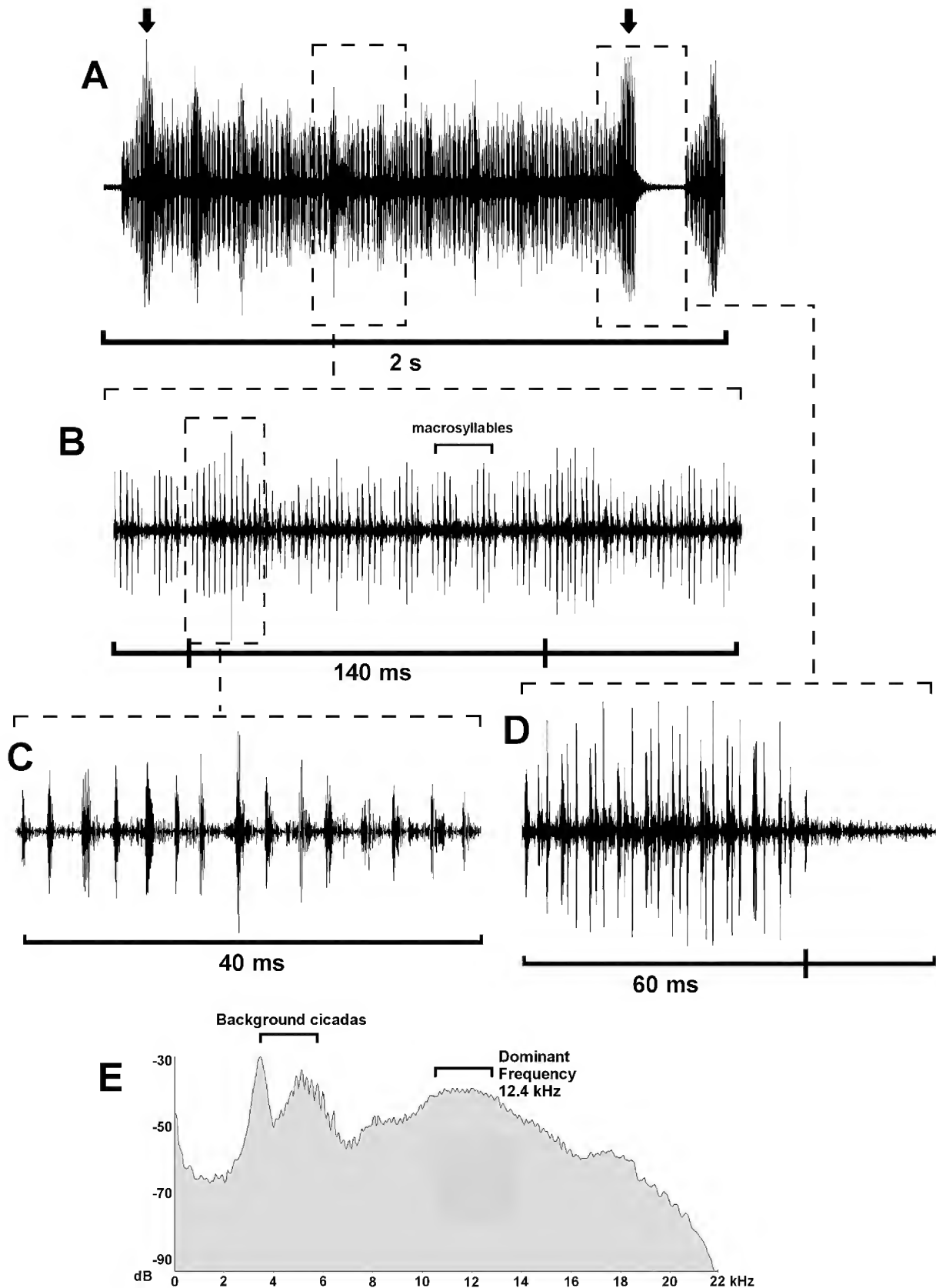
black longitudinal markings either side of midline, with brownish pubescence (Fig. 52C).

**Genitalia** (Fig. 20). Pygofer black, posterior border below dorsal beak and around upper lobe variably brown-ochraceous; dorsal beak black, anal styles pale brown; upper lobe mainly black, variably pale brown on posterior borders; basal lobe black. Uncus brownish; in lateral view beak-like; lobes in ventral view bulbous, with tapering lateral termination; claspers clearly divided, short, with apices gradually tapering laterally. Aedeagus with pseudoparameres extending around two-thirds the length of theca; theca recurved ventrally at 120° towards apex, with a transparent flange along the outer margin of recurvature, this broadly smooth, similar width to theca, terminating before apex; apex short, knob-like, with distinct cornuti around base.

**Female** (Fig. 19C–F). **Head** colour on dark specimens similar to male (Fig. 19C), orange-brown on lighter specimens with black marking around ocelli and supra-antennal plate, black spot at medial border of eye.

**Thorax** with a much greater range of brown coloration than





**Figure 21.** Male calling song structure of *Yoyetta regalis* sp. nov., illustrated in waveform plots, including (A) a complete single echeme phrase with amplitude inflections indicated by downward pointing arrows (further detail in text); (B) expanded section from the middle of the echeme (in A) showing minor amplitude modulations and intervening macrosyllables; (C) further expanded detail of a minor amplitude modulation showing clean syllable structure; (D) expanded detail of an amplitude inflection showing dense structure. The final subfigure (E) is a spectrogram displaying song frequency. This specimen was recorded at Wises Track, Audley (34°08'S 151°03'E) by LWP using RS1 (see *Methods and terminology*).

males, mainly black on some specimens, with pronotal collar black; on brown specimens, black markings restricted to lateral and posterior margins around a broad brown midline strip, variably along fissures, pronotal collar brown, with lateral angles black; mesonotum black on dark specimens, cruciform elevation black, lateral depressions with variable brown mottling, metanotum black; mesonotum brown on pale specimens, patchy black markings over submedial and lateral sigilla, cruciform elevation yellow-ochraceous, lateral depressions ochraceous, anterior and posterior depressions dark brown to black, scutal depressions black, metanotum black.

**Abdomen.** Colour variation similar to thorax. On dark specimens, similar to male; sternite VII ochraceous with variable black mark on anterior margin; abdominal segment 9 black dorsally, becoming orange laterally with lateral black spot. On pale specimens, tergite 1 black; tergites 2–8 orange brown, anterior margins black, reducing posteriorly, black midline markings reducing posteriorly, becoming blacker towards lateral margins, black transverse stippling along central segment of tergites; epipleurites almost entirely pale brown; sternite II black; sternites III–VI pale brown with midline black marking; sternite VII pale brown with anterior black line directed posterolaterally; abdominal segment 9 brown with three longitudinal black stripes on midline and either side of midline, darker brown spot in lateral depression. On all specimens, dorsal beak black; ovipositor light brown, becoming black at tip, extending > 1 mm beyond apex of abdominal segment 9. Anal styles orange-red; ovipositor sheath dark brown to black.

**Measurements** (in mm; range with mean in parentheses: 12 males, 12 females). Body length: male 23.5–25.2 (24.8); female 25.6–29.0 (27.5). Fore wing length: male 26.8–29.8 (28.5); female 29.7–33.5 (32.1). Head width: male 7.1–7.7 (7.4); female 7.9–8.2 (8.0). Pronotum width: male 6.7–7.6 (7.1); female 7.4–8.6 (8.0). Abdomen width: male 6.7–7.3 (6.9); female 6.9–8.0 (7.6). Ovipositor length 8.8–10.6 (9.7).

**Etymology.** From the Latin “*regalis*”, meaning royal or kingly, reflecting the stately coloration and song of this species as well as its abundance in the Royal National Park, south of Sydney.

**Distinguishing features.** Within the *Y. abdominalis* species group, *Y. regalis* sp. nov. is superficially similar in appearance to *Y. abdominalis*, *Y. electrica* sp. nov., *Y. grandis* sp. nov., *Y. spectabilis* sp. nov., *Y. serrata* sp. nov., *Y. subalpina* sp. nov. and *Y. verrens* sp. nov. Nevertheless, *Y. regalis* sp. nov. is readily distinguished from *Y. abdominalis*, *Y. electrica* sp. nov., *Y. spectabilis* sp. nov. and *Y. serrata* sp. nov. by the following combination of characters: (1) large size with body length > 23 mm, (2) lack of symmetrical, orange triangular patterns on tergites 4–7, (3) ovipositors of females extend > 1 mm beyond the posterior abdomen. The forewing basal membrane of *Y. regalis* sp. nov. is orange, in contrast to the grey or pale orange coloration in *Y. grandis* sp. nov. Geographically, populations of *Y. regalis* sp. nov. do not overlap with those of *Y. grandis* sp. nov. and only marginally with *Y. subalpina* sp. nov. Variations in the phenotype of male *Y. regalis* sp. nov., *Y. subalpina* sp. nov., *Y. verrens* sp. nov. and, *Y. grandis* sp. nov. make differentiation difficult. However, the black midline markings on the sternites are far more prominent in *Y. regalis* sp. nov. than in *Y. subalpina* sp. nov. or *Y. grandis*

sp. nov. In *Y. regalis* sp. nov., the white colouration on the hind wing plaga is bold and extends to cover the entire jugum. Contrastingly, in *Y. verrens* sp. nov. the colouration is dull white and restricted along the margins of anal cell 3 and vein 2A. In female specimens, the ovipositors extend beyond the abdomen around 1.0 mm for *Y. subalpina* sp. nov., 1–1.5 mm for *Y. regalis* sp. nov. and > 1.5 mm for *Y. grandis* sp. nov. The length of the ovipositor of *Y. regalis* sp. nov. is > 8.8 mm, < 8.6 mm for *Y. subalpina* sp. nov. and > 10.0 mm for *Y. grandis* sp. nov. and *Y. verrens* sp. nov.

**Calling song** (Fig. 21, 53L). Males of *Y. regalis* sp. nov. produce a distinct, rapidly emitted, calling song with correspondingly rapid and regular amplitude modulations (Fig. 21). Each separate phrase appears to comprise a single echeme, with the most conspicuous amplitude inflections occurring at the beginning and end of each echeme (Fig. 21A). Smaller amplitude modulations occur in the intervening duration between these inflections. This gives the song a “swirling” quality. Closer inspection of the echeme reveals that it is composed of well-defined syllables (Figs 20B, 21C), some of which are organized into a series of closely-spaced macrosyllables immediately prior to each minor amplitude modulation (Fig. 21B). The amplitude inflections at the beginning and end of each echeme have a denser (less defined) syllable structure (Fig. 21D). Recordings of individuals around Sydney Basin (n = 10) illustrate significant variation in the length of the single echeme phrases. Phrases at the start of a bout of calling song range from c. 5–12 s duration. Phrases for the remainder of the song are slower (between c. 13.5 s duration). When males are actively calling, a gap of 0.08–1.8 s duration typically separates each series of phrases. In some instances, these single echeme phrases are preceded (or succeeded) by intervening short chirps (short echemes or long macrosyllables, 0.06–0.08 s duration, separated by gaps of c. 1–5 s), which may serve to elicit a response from a nearby female (not illustrated). These short chirps are produced with increasing frequency immediately before taking flight. It has been noted that males in Royal National Park accelerate the emission rate of their song immediately before taking flight, and tick in flight.

The highest frequency plateau ranges from 8.2–15.4 kHz, with a dominant frequency of 10.3–13.3 kHz (Fig. 21E).

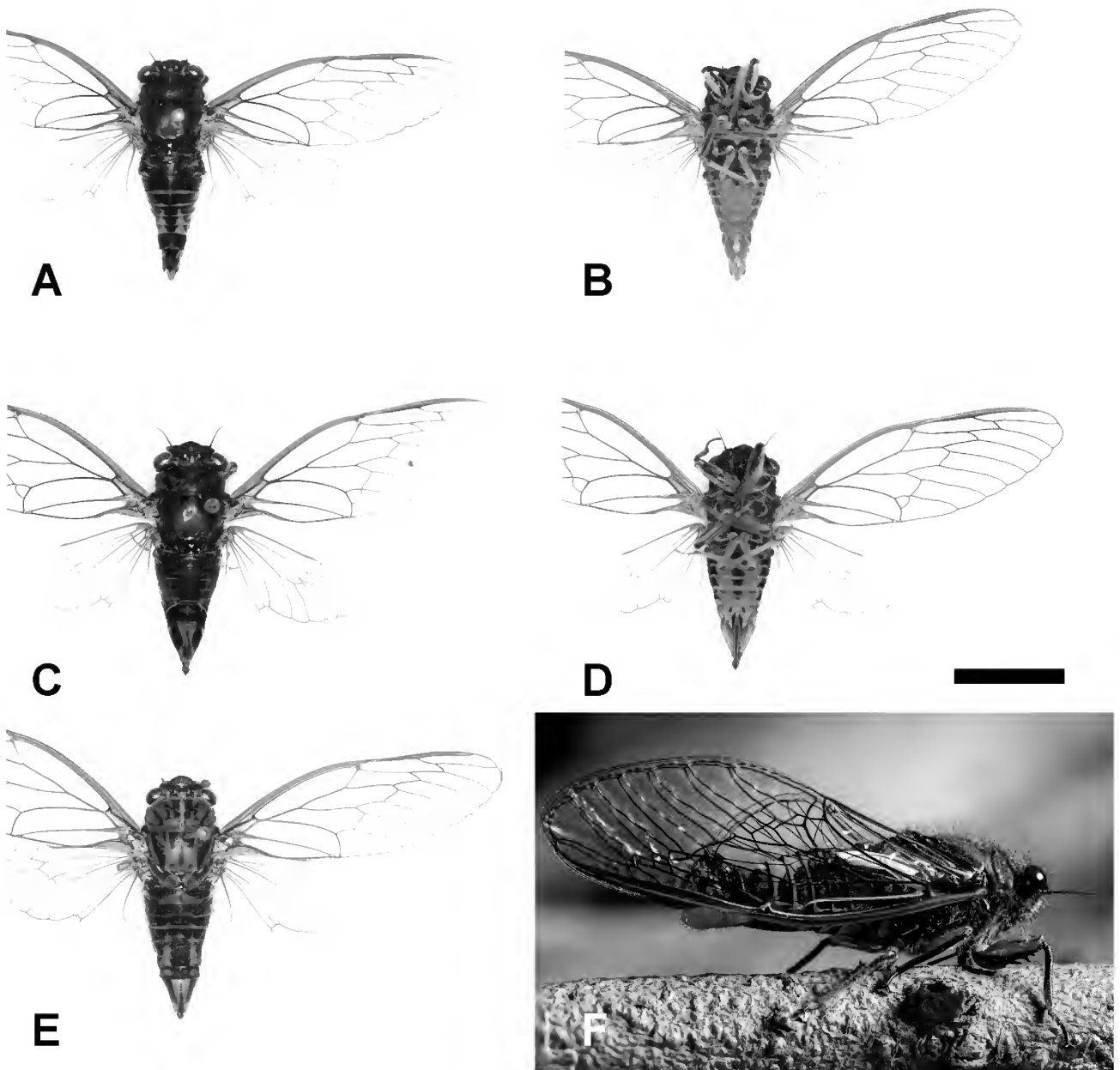
The rapid amplitude modulations render the song of *Y. regalis* sp. nov. distinct among its relatives. One other species, *Y. spectabilis* sp. nov. produces similar modulations; however modulations occur at a much slower rate than in *Y. regalis* sp. nov.

### *Yoyetta spectabilis* sp. nov.

<http://zoobank.org/NomenclaturalActs/1EE2E4AA-B0B5-4BA0-A67D-11906570A804>

Figs 2D, 3D, 22–25, 52D, 53K

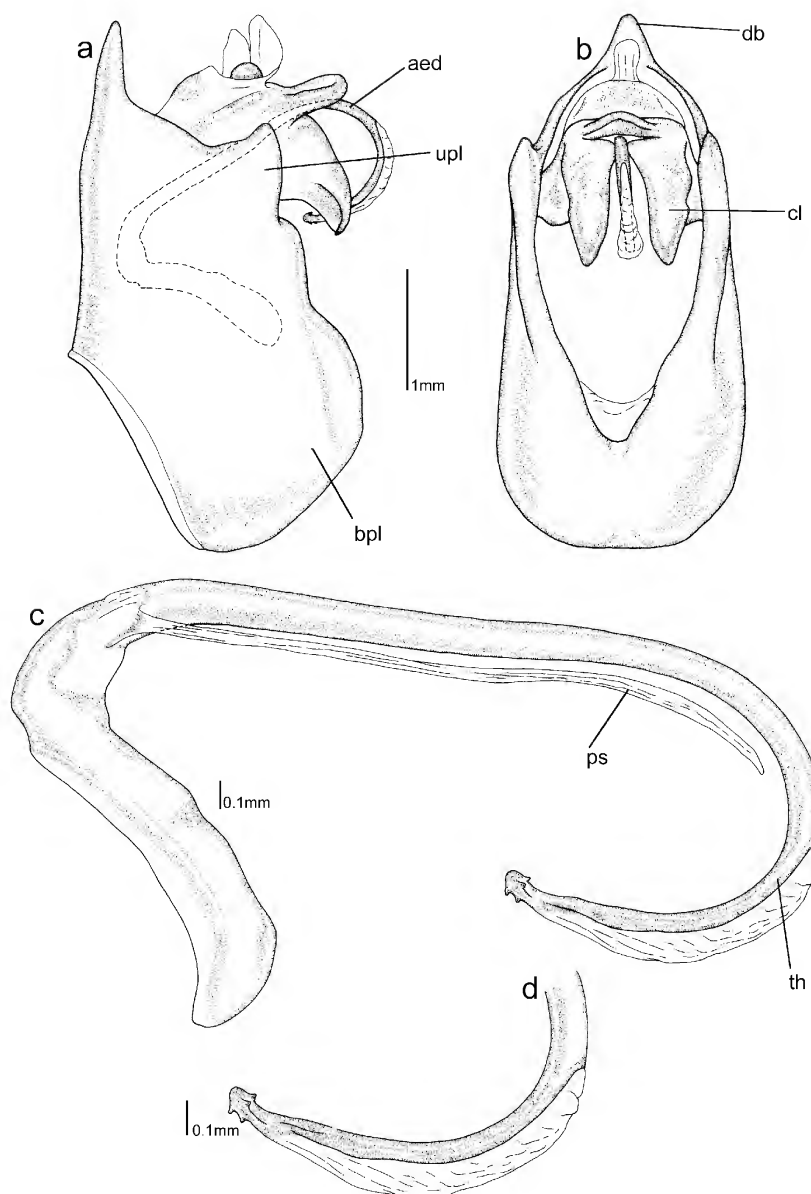
**Holotype** ♂, Wises Track, Royal National Park, NSW, 34°06'51"S 151°03'30"E, 9.i.2005, S. N. & D. Emery (AM K.536052). **Paratypes** NEW SOUTH WALES: 1♂ 1♀, Australia NSW, Morton NP, Malaise on edge between open field & woodland *Leptospermum* understorey, off Touga Rd, 1–8.xii.2009, C. Manchester, D. Yeates, B. Lessard, ANIC Bulk Sample No. 3381, 35°02'35"S 150°08'31"E GPS; 2♂♂, Australia NSW, Clyde Mountain (near top of highway pass), 28.xii.1994; A. Sundholm & R. De Keyzer; 1♂, Blue Mtns 1899, W. W. Froggatt collection (ANIC); 1♀, Park Rd, Waitara, NSW, 33°42'31"S 151°06'27"E, 17.xii.1996, M. S. Moulds; 1♀, Knapsack St, Glenbrook, NSW, 33°45'46"S 150°38'17"E, 10.xi.1997, D. Emery; 1♂ 1♀,



**Figure 22.** *Yoyetta spectabilis* sp. nov., (A) male holotype, Kuringai Chase National Park (33°40'S 151°12'E), dorsal habitus; (B) male, ventral habitus; (C) female, Royal National Park (34°06'S 151°03'E), dorsal habitus; (D), female, Royal National Park, ventral habitus; (E), female, Barren Grounds (34°41'S 150°44'E), brown variant, dorsal habitus; (F), live male specimen, Blackheath (33°35'S 150°50'E), photo by NJE. Scale bar (for preserved specimens) = 10 mm.

Barren Ground Nature Reserve, NSW, 34°42'43"S 150°42'21"E, 15.i.1999, S., N. & D. Emery; 3♂♂ 2♀♀ same location, 15.i.2000, S. & D. Emery; 6♂♂ same location, 1.i.2004, S. & D. Emery; 2♂♂, same location, 29.xii.2005, N. & D. Emery; 2♂♂, Clarence, NSW, 6.xii.2000, R. Chin; 2♂♂ 1♀, Blackheath, NSW, 33°36'44"S 150°19'28"E, 23.xi.2002, D. Emery & L. Popple; 1♂, same location, 14.xii.2002, D. Emery; 2♂♂, same location, 22.xii.2002, N. & D. Emery; 2♂♂, 20 km SW Nowra, NSW, 35°01'35"S 150°28'37"E, 1.i.15, S., N., C. & D. Emery; 1♂, Berrara, 17.x.2015, N. Emery; 2♂♂, Medway, NSW, 34°29'25"S 150°16'27"E, 6.i.17, S., N. & D. Emery & T. Corbin; 3♂♂, Dolphin Point, NSW, 36°25'41"S 150°26'40"E, 19–28.i.2018, J. Poyitt (DE); 2♂♂, same location, 19–28.i.2018, J. Poyitt; 1♂, same location, 2.i.2014, J. Poyitt (JP); 1♂, Bendalong, NSW, 26.xii.1968, G. Daniels; 1♀, Royal National Park, NSW, 7.ii.1986, C. N. Smithers; 1♂, "Tuglo", 60 km N Singleton, NSW, 13.xi.1983, B. Day & K. Kloof; 2♂♂, Macquarie Pass, NSW, 28.xii.1992, T. M. S. Hanlon; 6♂♂, Barren Ground Picnic Area, NSW, 10.i.2006, D. Britton (AM); 2♂♂, Blackheath, 23.xi.2002, L. Popple, D. Emery, 513-0001, 513-0002; 1♀, Barren Grounds, 31.xi.2003, L. Popple, D. Emery; 3♂♂, Burradoo via Jamberoo, 31.xi.2003, L. Popple, D. Emery, 513-0004 to 513-0006, 1♂, Genitalia prep. 513-01; 2♂♂, Kanangra

Walls, 33°59'19"S 150°05'32"E, S12588, Heathland, 9.i.2010, Popple & Emery, 513-0008, 513-0009; 1♂, Kanangra-Boyd National Park, 33°53'10"S 150°45'23"E, S12588, 9.i.2010, Popple & Emery, 513-0007; 1♂, Blackheath, i.2010, D. Emery, 513 (LWP); 1♂, Ulladulla, 23.xii.1994, M. S. & B. J. Moulds; 5♂♂, Hat Hill, Blue Mountain Nat. Pk, 5.xii.1971, G. Daniels; 1♂ 1♀, same data, 30.xi.1975; 3♂♂, Kanangra Walls, 23.xii.1973, G. Daniels; 1♂, Wentworth Falls, Blue Mountains, xii.1990, Keith Chambers; 3♂♂ 1♀, Hat Hill, Blackheath, 24.xi.1973, G. Daniels; 1♂, Cudmirrah Faunal Reserve, 24.xii.1974, G. Daniels; 1♂, Mt Leighton Bailey, Royal Nat. Pk, 2.ii.1978, G. Daniels; 1♂, 8 km E Robertson, 12.xii.1976, G. Daniels; 1♂, George Boyd Lookout, nr Ulladulla, 12.xii.1990, A. Sundholm; 1♂, Bobbin Head, Ku-Ring-Gai Chase National Park, 16.ii.1970, J. Barratt; 1♂, Budderoo Fire Trail, approx. 18 km SE Robertson, 18.xi.1984, G. Williams, ex. woodland; 1♂, Currarong, 24.i.1993, T. M. S. Hanlon; 7♂♂, Hat Hill, Blackheath, Blue Mts, 11.xii.1971, J. V. Peters; 1♂, Mt Wilson, Blue Mountains, 30.xi.1975, G. Daniels; 1♂ 1♀, Jenolan Caves, 30.xii.1991, R. Eastwood; 2♂♂, Clyde Mt, 28.xii.1994, R. de Keyser & A. Sundholm; 1♀, Tinderry Rg, 10.xii.1961, L. A. Greenup; 1♂, Jct Rawson Pde and Mt Hay Rd, N. of Leura, 33°42.215'S 150°20.308'E, 980 m [elev.], 14.i.2011,



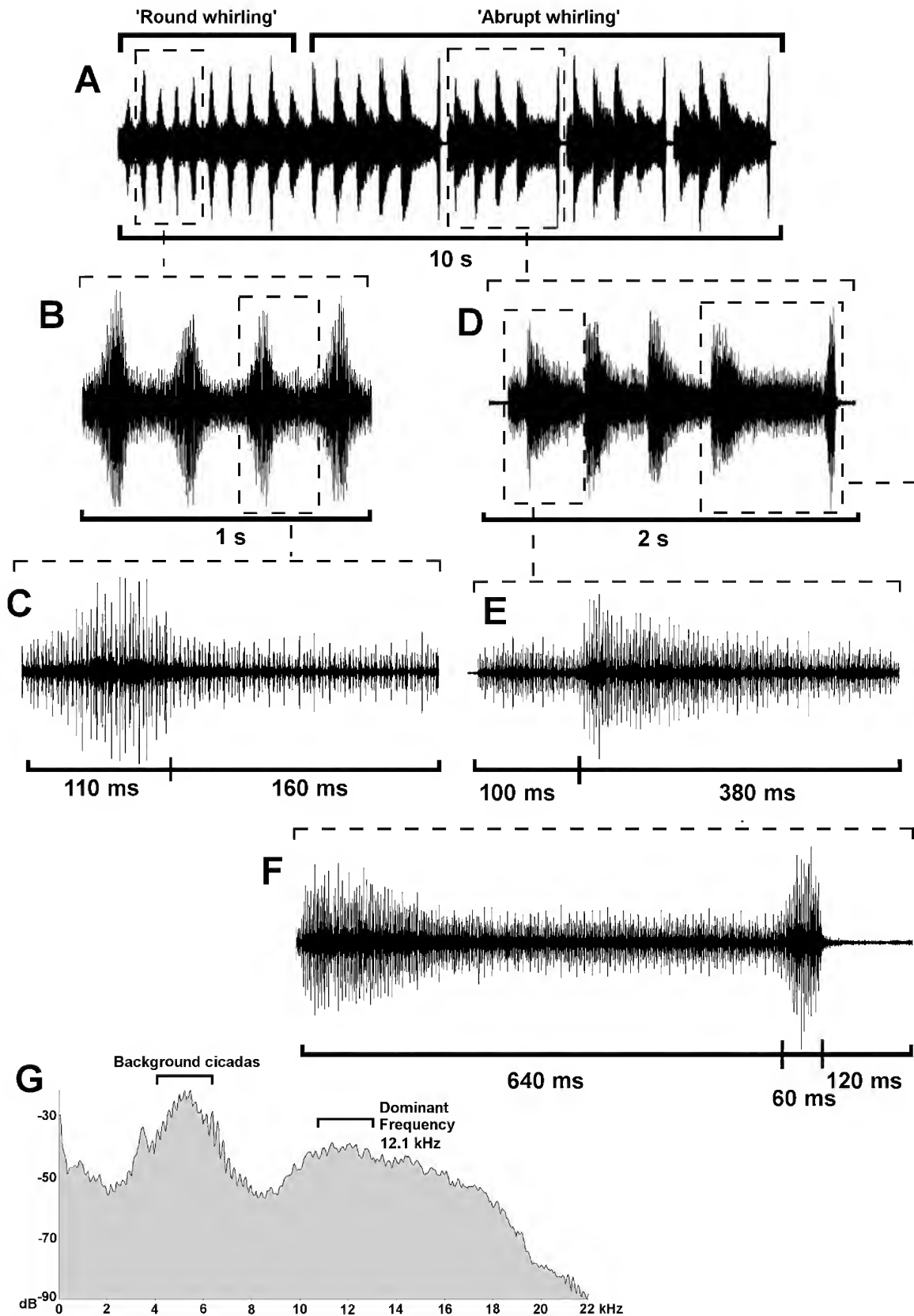
**Figure 23.** *Yoyetta spectabilis* sp. nov., illustration of male pygofer and internal genitalia; (a) viewed laterally from the left; (b) viewed ventrally; (c) aedeagus; and (d) apex of theca. Characters as depicted in Fig. 4. Specimen from Barren Grounds (34°41'S 150°44'E).

K. Hill, D. Marshall, AU.NS.MHA, C. Simon lab voucher, *Yoyetta* “zizzer”, legs in ETOH, 11.AU.NS.MHA.03; (MSM); 1♀, Tubrabucca, Barrington Tops, NSW, 31°52'S 151°25'E, 17.i.1948 (HEM2218); 1♂, Barrington, NSW, 31°59'S 151°55'E, 17.xii.1921 (HEM2219); (MMV). AUSTRALIAN CAPITAL TERRITORY: 2♂♂, Jervis Bay, ACT, 33°45'24"S 150°44'55"E, 12.xii.10, N. & D. Emery (DE). VICTORIA: 1♂, Shady Ck V., 7 km N. Yarragon, 7.i.1983, D. F. Crosby; 1♂ 1♀, N. Walkerville, 28.xii.1988, H. Abbott (MSM); 2♂♂, Tyers River, Moondarra Vic, 28.xii.1976, W. N. B. Quick (ANIC); 1♂, Yinnar, Vic, 38°19'S 146°19'E, 5.i.1952 (HEM2237); 1♂, same location, 16.xii.1948 (HEM2238) (MMV); 1♂, Narre Warren, 21.i.62; 2♀♀, Upper B'field, 13.i.1998 (QM); 1♂, Berwick, Victoria, G. J. Hall, 13.i.1924, *Melampsalta abdominalis* Dist., det. G. J. Hall after Nat. Mus. Vict., SAMA Database no. 20-014466 (SAM).

**Other material.** NEW SOUTH WALES: 4♂♂, Hat Hill Rd., Blackheath, NSW, 33°36'59"S 150°18'29"E, 19.xii.2007, C. & D. Emery; 1♀, same location, 10.i.2006, D. Emery; 1♂, Wisers Track, Royal National Park, NSW, 34°06'51"S 151°03'30"E, 9–13.i.2005, S. N. & D. Emery; 4♂♂, same location, 22.i.2007, S., N. & D. Emery; 5♂♂ 1♀, Budaroo National Park, NSW, 34°36'44"S 150°42'05"E, 30.xi.2003, S. & D. Emery & L. Popple; 11♂♂ 7♀♀, same location, 27.i.2007, S. & D. Emery; 8♂♂, same location, 1.i.2004, S. N. & D. Emery; 2♂♂ 1♀, Anvil Rock, NSW, 33°35'44"S

150°20'00"E, 6.xii.2009, D. Emery; 3♂♂ 1♀, same location, 9.xii.2009, D. Emery; 1♂, Kuringai Chase National Park, NSW, 33°40'34"S 151°12'52"E, 14.xii.2009, D. Emery; 2♂♂, St. Ives Showground, NSW, 33°42'22"S 151°11'21"E, 5–6.i.2010, D. Emery; 1♂, Kanangra Walls, NSW, 33°59'18"S 150°02'25"E, 8.i.2010, D. Emery & L. Popple; 6♂♂ 1♀, Kangaroo Track, Barren Ground Reserve, NSW, 34°41'40"S 150°44'19"E, 28.xii.2010, T., S., N., C. & D. Emery; 3♂♂, Lockley's Pylon Track, Leura, NSW, 33°36'05"S 150°20'00"E, 20.xii.2012, N. & D. Emery; 5♂♂, same location, 7.xii.13, A. Greenville & N. Emery; 1♂ 1♀, same location, 2.xii.14, T., S., N., C. & D. Emery; 1♂, same location, 2.xii.14, A. Schreiber; 1♂, same location, 12.xii.14, N. Emery; 1♀, Bundanoon, NSW, 19.i.2012, G. Bellis (DE). VICTORIA: 1♂, [labels in handwriting of J. H. Ashton] *M. abdominalis* Dist. Vic., K30137 [typed], genitalia preparation [handwritten] Y029, AM K.307108 (donated in 1911).

**Distribution, habitat and seasonality.** Highland locations from Barrington Tops south to the Southern Highlands of New South Wales. Specimens have been found in coastal locations from northern Sydney, south to eastern Victoria, close the Melbourne (Fig. 18). Adults occur mainly on small heath shrubs and sometimes on eucalypts. Males constantly



**Figure 24.** Male calling song structure of *Yoyetta spectabilis* sp. nov, illustrated in waveform plots, including (A) a series of echemes, including an introductory echeme and three typical echemes, illustrating the "round whirling" and "abrupt whirling" modulations (explained in the text); (B) expanded section of the round whirling from the introductory echeme (in A) showing rounded amplitude modulations; (C) further expanded detail of a round whirling amplitude modulation; (D) expanded detail of a typical echeme (in A) showing the abrupt whirling modulations; (E) expanded detail of an abrupt whirling amplitude modulation (from D); (F) expanded (from D) to show an abrupt modulation followed by the terminal modulation (explained in text). The final subfigure (G) is a spectrogram displaying song frequency. The specimen was recorded in the field at Wises Track, Audley (34°08'S 151°03'E) by LWP using RS1 (see *Methods and terminology*).

move between singing stations that are usually < 3 m high. Females are located close to ground level. Since their song is somewhat similar to that of *Y. regalis* sp. nov., the location of *Y. spectabilis* sp. nov. on the heathland shrubs contrasts with the distinct preference of the former species for smooth-barked eucalypts when the two species cohabit open woodland. This species can be encountered from late November to January.

### Description

**Male** (Figs 2D, 3D, 22A,B,F, 52D). *Head* almost as wide as mesonotum, black in mountain specimens, with a small, triangular brown fascia posterior to ocelli, reducing anteriorly, and a small to large ochraceous spot on posterior margin between ocelli and eye; covered with black pubescence. In coastal specimens, including the holotype, pale brown to ochraceous posteriorly, extending halfway around eye, black surrounding ocelli, black spot medial to eye; ocelli pink; postclypeus dorsally dark brown to black with yellowish triangular median fascia, apex directed anteriorly, ventral surface black with black transverse grooves, midline with ochraceous line over anterior half in some specimens, lateral and posterior borders ochraceous, tending reddish; anteclypeus black, rostrum black at base, dark brown centrally, black at apex, reaching anterior edge of hind coxae; lora ochraceous anteriorly, variably black on medial and posterior sections; eyes variably dull black to dark brown; antennae black, supra-antennal plates black, coastal specimens with central brown spot on anterior margin extending laterally above pedicel.

*Thorax* predominantly dull black on mountain specimens, brown on coastal cicadas. Pronotum black with distinct ochraceous marking over central third of midline, variably bordered by black, fissures variably black, tending brown on raised areas; pronotal collar brown centrally, variably tending black laterally, lateral angles black, paranota black on posterior and lateral margins, becoming brown elsewhere. Mesonotum black on mountain cicadas, coastal specimens brown with sigilla, scutal depressions and surrounds black; cruciform elevation arms black, lateral depressions brown. Metanotum black.

*Legs*. Coxae mainly black and ochraceous, fore coxae with anterior black markings ranging from proximal spot to a longitudinal stripe, mid and hind coxae black, variably ochraceous laterally, membranes red; meracantha small, narrow, reddish, black at base, pointed, overlapping one-quarter of opercula; trochanters red with black medial stripe; femora red laterally, black medially; femoral spines erect, reddish to black at base tending dark brown at tips; fore tibiae black, tending brown distally, browner on coastal specimens; mid tibiae ochraceous with proximal black stripe, hind tibiae pale brown with variable, small black marking on medial aspect of proximal segment; tarsi on coastal specimens reddish tending black at distal joints, fore tarsi brown on mountain specimens becoming black towards claws, mid tarsi light red with black at claws, hind tarsi red with brown at claws; claws dark brown, black at tips.

*Wings* with fore wing costal veins orange-red, proximal margin black posteriorly; pterostigma mottled red; basal cell hyaline with black anterior border; basal membranes bright orange-red, other veins dark brown to black, with eight apical cells; hind wing plagas white over entire anal cell 3 and thin along vein 2A, some reddish stippling at base, with six apical cells.

*Opercula* (Fig. 3D) small, spatulate, following body axis ventrolaterally, depressed centrally, variably black at base, orange-red across remainder, clearly separated.

*Timbals* (Fig. 2D) with five distinct long ribs; long ribs 1–3 extending across surrounding membrane and fused dorsally along basal spur; long rib 4 discontinuous at proximal third; long rib 5 independent of basal spur, comparatively shorter, extending ventrally across half of membrane; large ridged dome on posterior timbal plate extending across two-thirds of timbal; apodeme pit oval-shaped and conspicuous.

*Abdomen*. Tergite 1 black with red lateral membranes; tergites 2–3 black with diffuse dark brown shading on some coastal specimens, intersegmental membranes orange; tergites 4–7 black with thin orange posterior margins, an increasing area of lateral orange coloration posteriorly forming a triangular shape with base on tergite 7, extending to lateral border and to epipleurite 7; tergite 8 shiny black, with orange-red posteriorly and extending laterally in some specimens. Epipleurites with variable black medial markings, fiery red laterally and posteriorly. Sternite II mainly black; sternite III black centrally, orange-red laterally; sternites IV–VI orange, posterior halves becoming red, black midline markings over anterior two-thirds of each sternite, decreasing posteriorly, sternite VIII fiery red, with yellowish pubescence (Fig. 51D).

*Genitalia* (Fig. 23). Pygofer black, dorsal beak black, anal styles bright red; upper lobe black; basal lobe black. Uncus reddish-brown, orange-brown laterally; in lateral view beak-like; lobes in ventral view narrow, with rounded lateral termination; claspers clearly divided, short, with apices tapering laterally. Aedeagus with pseudoparameres extending around three-quarters the length of theca; theca recurved ventrally around 180° towards apex, with transparent flange along dorsal margin of distal half of recurvature, broadly smooth, equal to width of theca; apex short, knob-like, with 6–8 prominent cornuti.

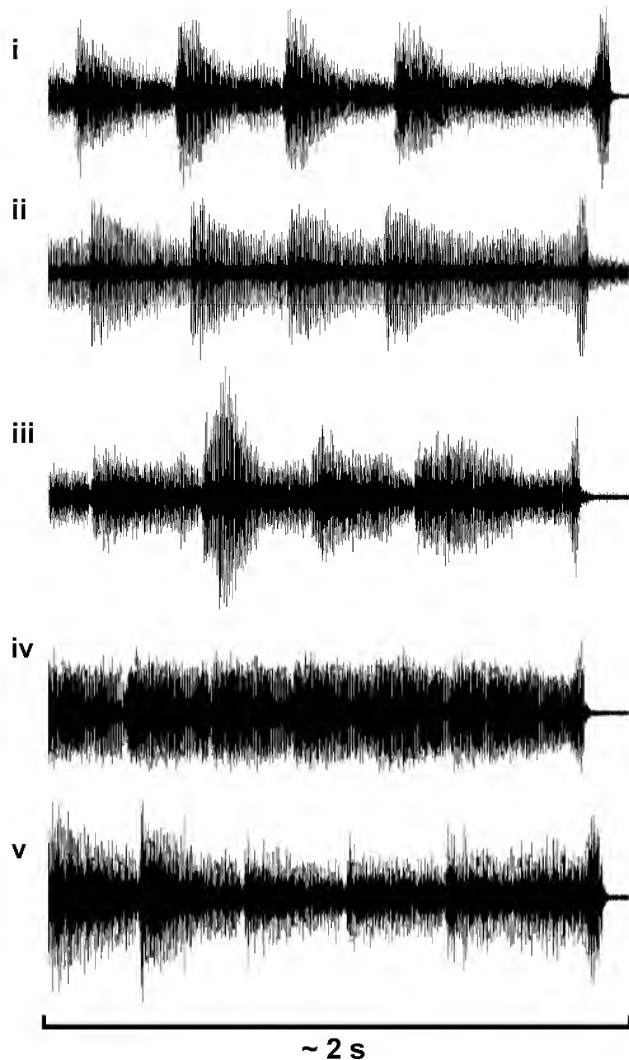
**Female** (Fig. 22C–E). *Head* and *thorax* similar to male, and with patterns of black and brown markings within the range described for coastal and mountain male specimens.

*Abdomen* similar to coastal and mountain male specimens for the range of markings on tergites and sternites; sternites III–VII becoming more orange-red posteriorly, with midline black marking also reducing progressively from sternite III to sternite VII; abdominal segment 9 black dorsally with orange longitudinal stripes either side of midline, curving anteriorly and becoming orange to red laterally and ventrally; dorsal beak black. Ovipositor brown, black at tip, not extending beyond apex of abdominal segment 9. Anal styles bright red; ovipositor sheath dark brown to black.

**Measurements** (in mm; range with mean in parentheses: 12 males, 12 females). Body length: male 19.6–22.7 (21.0); female 21.4–26.5 (22.6). Fore wing length: male 23.4–26.7 (24.8); female 26.3–28.4 (26.9). Head width: male 6.0–6.8 (6.5); female 6.9–7.3 (7.1). Pronotum width: male 6.0–6.7 (6.3); female 6.3–7.3 (6.8). Abdomen width: male 5.8–6.5 (6.4); female 6.0–7.3 (6.7). Ovipositor length 6.1–6.8 (6.5).

**Etymology.** “*Spectabilis*” (Latin) depicts the impressive coloration and markings that range from orange-red to enamel black in this species.

**Distinguishing features.** *Yoyetta spectabilis* sp. nov. is readily distinguished from *Y. denisoni*, *Y. timothyi* sp.



**Figure 25.** Comparative structures of a single phrase from the calling songs of *Yoyetta spectabilis* sp. nov. from a range of locations, including: (i) Wises Track, Audley (34°08'S 151°03'E); (ii) Budderoo (34°39'S 150°45'E); (iii) Barren Grounds (34°41'S 150°44'E); (iv) Kanangra Boyd National Park (33°53'S 150°03'E); (v) Blackheath (33°35'S 150°50'E). Specimens were recorded in the field by LWP using RS1 (i, ii, iii, v) or RS2 (iv).

nov., *Y. kershawi* stat. rev., comb. nov., *Y. regalis* sp. nov., *Y. grandis* sp. nov., *Y. subalpina* sp. nov., *Y. grandis* sp. nov. and *Y. verrens* sp. nov. by the following combination of characters: (1) smaller size with body length < 23 mm, (2) presence of symmetrical, orange triangular patterns on tergites 4–7, and (3) ovipositor sheaths of females not extending beyond the apex of abdominal segment 9. It differs from *Y. hunterorum*, which has the opercula and sternite 8 dull brown, the female abdominal segment 9 without red markings and the female ovipositor sheath extending > 1.5 mm beyond the apex of the abdomen. The orange triangular patterning on the tergites of *Y. spectabilis* sp. nov. is distinct from the annular banding on *Y. electrica* sp. nov. which is also smaller (BL < 18 mm).

Specimens of *Y. spectabilis* sp. nov. can be difficult to distinguish from *Y. serrata* sp. nov. and some specimens of *Y. abdominalis*, which have a similar range of shapes, sizes and markings. While the calling songs are quite

distinctive, *Y. spectabilis* sp. nov. can also be distinguished from *Y. abdominalis* and *Y. serrata* sp. nov. by the following combination of characters: (1) lack of longitudinal central fascia on the pronotum in male specimens; (2), the colouration of the male opercula, which is predominantly red (cf. dull reddish-brown in *Y. serrata* sp. nov. and black to pale brown in *Y. abdominalis*); (3), the forewing costa and basal membrane is bright orange-red; (4) epipleurites boldly red and black.

**Calling song** (Figs 24, 25, 53K). The male calling song of *Y. spectabilis* sp. nov. consists of a series of “whirling” amplitude modulations and produced at rest. Close examination reveals that these are organized into long echemes. The calling song commences with an introductory echeme with rapidly-emitted and regular amplitude modulations (“round whirling”; Fig. 24A–C). Towards the end of the echeme, the rate of modulation decreases, with each modulation commencing abruptly and fading (“abrupt whirling”; Fig. 24A,D,E). Each echeme ends with a sharp terminal modulation equivalent to a macrosyllable (Fig. 24F). The first echeme is the longest, lasting about 5–8 s. The second echeme sometimes has the same form, though with a shorter round whirling section. The typical echemes following these introductory echeme(s) are simplified, losing the round whirling altogether and only exhibiting the abrupt whirling and sharp terminal modulation. A comparison between the typical echemes recorded at multiple sites in provided in Fig. 24. These typical echemes are around 2 s duration.

The highest frequency plateau for the 513 calling song ranges between 8.9–13.0 kHz, with a dominant frequency between 9.5–12.1 kHz (Fig. 24).

Within the genus *Yoyetta*, the calling song of *Y. spectabilis* sp. nov. most closely resembles that of *Y. regalis* sp. nov. The song of *Y. spectabilis* sp. nov. differs most noticeably in the slower modulation rate and the presence of both round whirling and abrupt whirling types of amplitude modulation (cf. one type of rapidly emitted amplitude modulation in *Y. regalis* sp. nov.). *Yoyetta spectabilis* sp. nov. also does not produce intervening short chirps between bouts of echemes, which is a feature of the song of *Y. regalis* sp. nov.

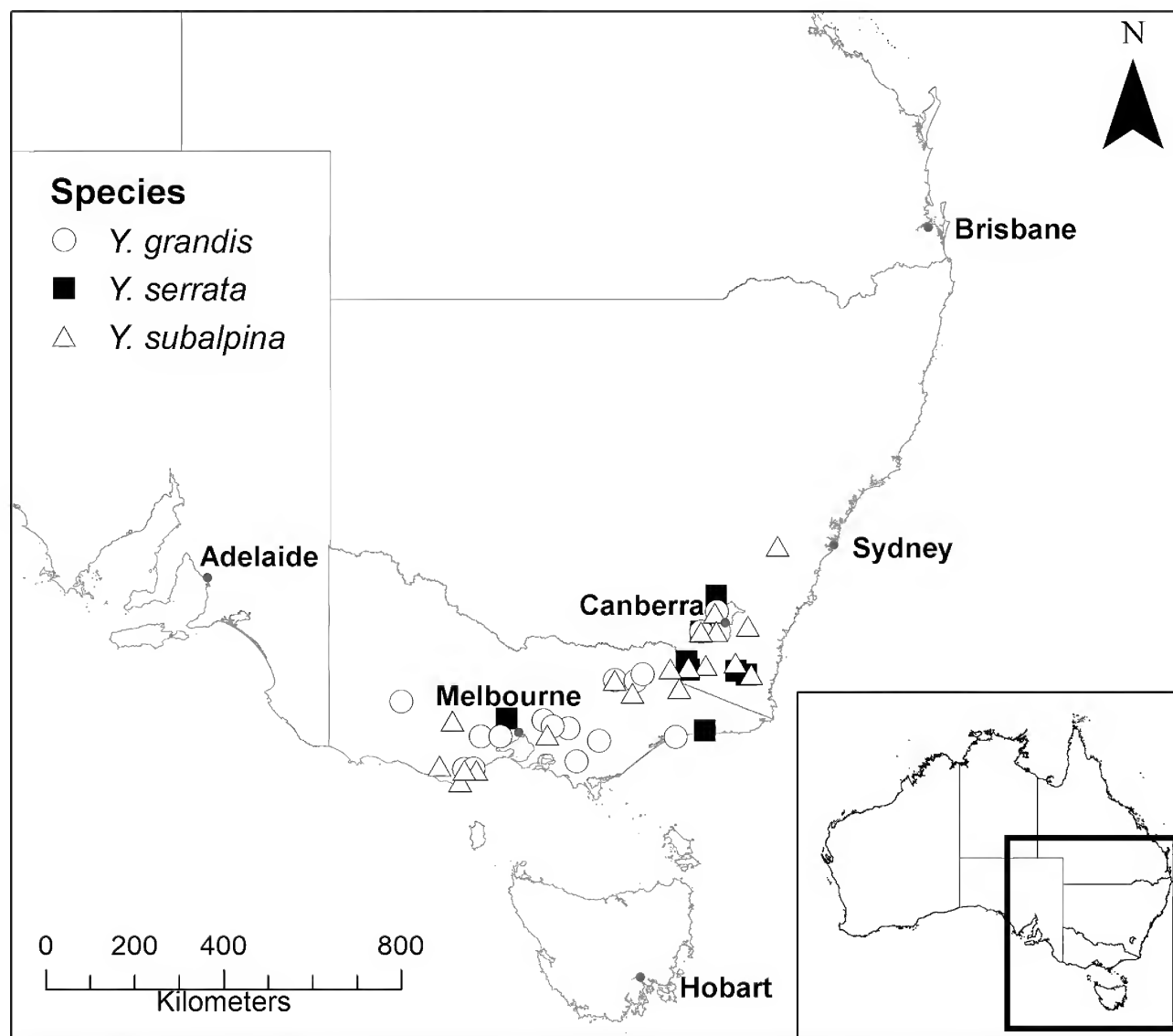
### *Yoyetta subalpina* sp. nov.

<http://zoobank.org/NomenclaturalActs/1C0EBF61-D05D-4EB6-A792-FFCD6012A489>

Figs 2E, 3E, 26–31, 52E, 53G

**Holotype** ♂, 18 km E Cooma, NSW, 36°20'47"S 148°13'57"E, 10.xii.2010, L. Popple, 514-0013 (AM K.559471). **Paratypes** NEW SOUTH WALES: 1♂1♀, Piccadilly Circus, Brindabella Ra., ACT, 35°21'S 148°48'E, 26.xii.1978, D. C. F. Rentz, ANIC Database no. 20 010822; 1♀, Snowy River, Mt Kosciusko, 4000FT, 12.xii.1931, L. F. Graham, ANIC Database No. 20 010821; 1♂, Old Adaminaby NSW, 24.i.1967, T. G. Campbell, ANIC Database no. 20 010820; 2♀♀, NSW Snowy Plains, 19.ii.1969, M. G. Stanger, on Eucalypt, [1♀] ANIC Database no. 20 010823; 1♀, Cooma NSW, 10.i.[19]06, Sellar, W. W. Froggatt collection, ANIC Database No. 20 010815; 1♂, Tinderry Mountains, Round Flat, netted, 1142 m, 25.xii.2014, 35°42'52.08"S 149°17'40.48"E, D. J. & R. L. Ferguson, ANIC Database No. 20 010718; 1♂, Tinderry Mountains, Tinderry Rd verge, netted, 1160 m, 35°43'49.17"S 149°18'07.92"E, 21.xii.2014, D. J. Ferguson, ANIC Database No. 20 010816 (ANIC); 2♂♂ 4♀♀, Mt Kosciusko, NSW, 36°27'S 148°16'E, 18.i.1931 (HEM2554–58); 1♀, Jindabyne NSW, 36°25'S 148°37'E, 17.i.1953, (HEM2559) (MMV); 4♂♂, 3♀♀, 1 km S. of Brown Mountain, via Nimmitabel, 36°36'16"S 149°22'31"E, 29.xii.2009, L. W. Popple, 514-0003 to 514-0009; 1♂, Tom Groggin Road, 18 km ESE of





**Figure 26.** Map of eastern Australia showing the geographical distribution of *Yoyetta subalpina* sp. nov. (open triangles), *Y. serrata* sp. nov. (closed squares) and *Y. grandis* sp. nov. (open circles).

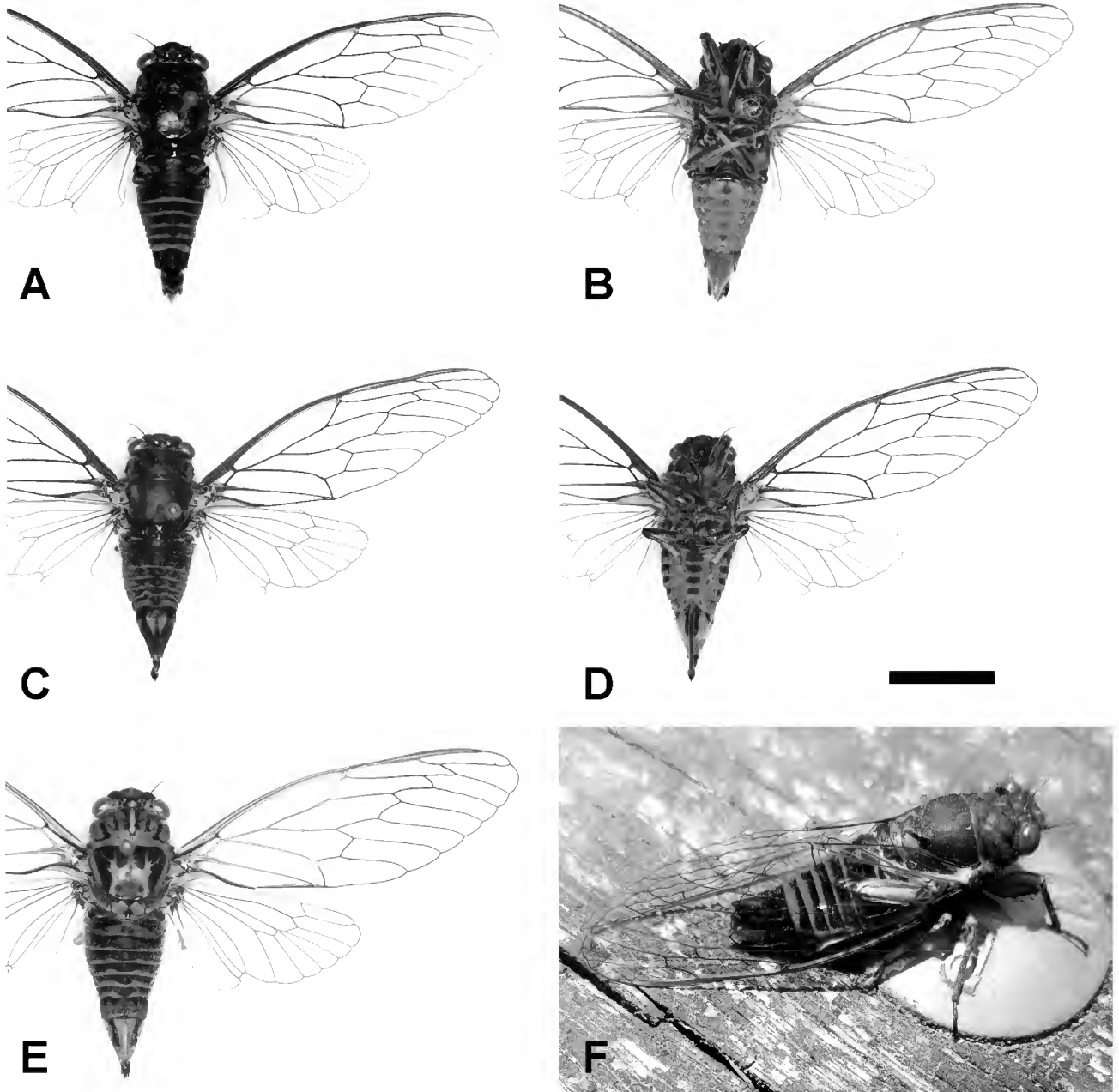
Cooma, 36°20'48"S 148°13'57"E, 10.xii.2010, L. W. Popple, 514-0014 (LWP); 1♀, 7 miles [SW of?] Countegany on Kybean Rd, 16.xii.19[62], L. R. G[reenup]?, 105; 1♂ 8♀♀, Mt David, 30 km SW of Oberon, 26.xii.1985, S. & B. Underwood; 1♂ 2♀♀, 12 mi. from Cooma on Nimitabelle [sic.] Rd, 27.xii.1973, Euc. pauciflora, L. R. G[reenup]; 3♂♂ 2♀♀, Yarrangobilly Caves road, Kosciuszko NP, 35°33.258'S 148°30.842'E, 17.i.2011, 1305 m [elev.], K. Hill, D. Marshall, AU.NS.YAX, C. Simon lab voucher, *Yoyetta* "double-zit"; 1♂, same data; legs in ETOH, body pinned, 11.AU.NS.YAX.01 (MSM); 1♂ 6♀♀, Piccadilly Circus, Brindabella Ranges, NSW, 35°21'34"S 148°47'59"E, 10–14.i.2002, D. Emery; 2♀♀, Kanangra Boyd National Park, NSW, 33°59'18"S 150°02'25"E, 8.i.2010, D. Emery & L. Popple (DE). VICTORIA: 1♂ Mt Buffalo Nat. Pk, 16.i.1966, T. Weir (UQIC); 1♀, 36°29'S 147°54'E, 8 km SE by E of Nariel Vic., 16.i.1984, K. H. L. Key; 1♀, 9 km E of Mt Pendergast, E of Benambra, Vic., 1325m, 36°53'S 148°05'E, 29.xii.1983, K. H. L. Key, ANIC Database No. 20 010819 (ANIC); 3♂♂ 3♀♀, midway between Harrietville & St Bernard Hospice, 19 Dec 1933, A. Musgrave (AM K.307236–41); 1♂, Sommerville Ave, Lorne, Vic, 15.xii.2002, D. J. Hilton; 2♀♀, 1 km SE Forrest, Otway Ranges, Vic, 38°54'39"S 143°74'40"E, 5.ii.15, S. Emery & T. Corbin; 1♂, Kinglake, Vic, 37°28'11"S 145°20'12"E, 17.xii.2016, S. Emery & T. Corbin; 2♂♂, Country Fire Authority Station, Toolangi, 37°32'32"S 145°28'29"E, 11.i.2017, S. Emery & T. Corbin (to light); 2♂♂, same location, 23.i.2017, N., C. & D. Emery (DE); 2♂♂ 9♀♀, Mt Hotham Alpine Reserve, 1,830 m [elev.], 2.i.1976, M. S. & B. J. Moulds (1♂ 1♀ in cop); 4♂♂, same data, 1.i.1976, 1♂ in cop; Mt Hotham Village, 36°59'S 147°11'E, 1–13.i.1990, G. R. Brown & M. A. Terras (MSM); 1♂, Kinglake, Vic, 37°32'S 145°20'E, 4.xii.1927, (HEM2611); 5♀♀, Mt Buffalo,

Vic, 36°43'S 146°46'E, 29.xii.1951 (HEM2612–16); 1♂, Country Fire Authority Station, Toolangi, 37°32'32"S 145°28'29"E, 27.xii.2018, S. Emery & T. Corbin (to light; T 22389); 5♂♂ 3♀♀, Allambee, Victoria, 14.i.2019, J. Green (HEM5765–7 [♀], HEM5768–72 [♂]) (MMV). AUSTRALIAN CAPITAL TERRITORY. 1♀, 35°21'S 148°48'E, Piccadilly Circus, Brindabella Ra. A.C.T., 26.xii.1978, D. C. F. Rentz (ANIC); 1♂, Mt Franklin Rd, Brindabella Ranges, 35°32'S 148°46'E, 5.xii.2004, B. Kenway, 514-0001; 1♂, Piccadilly Circus, Brindabella Range, 35°21'37"S 148°47'59"E, 28.xii.2009, L. W. Popple, 514-0002, LT2009371; 1♂ 1♀, 1.5 km N. of Bull's Head, 35°22'39"S 148°48'16"E, 15.i.2011, L. W. Popple, 514-0015, 514-0017, LT2009371; 1♀, Mt Franklin area, 35°29'23"S 148°45'48"E, 15.i.2011, L. W. Popple, 514-0018, LT2009371 (LWP).

**Additional records from song recordings** NEW SOUTH WALES: Rocky Pic Road, Talleganda National Park, NSW, 35°37'12"S 149°29'54"E, 5.xii.2009, L. W. Popple. VICTORIA: Ridge Rd, Mt Dandenong, 600 m, 37°49'28"S 145°21'34"E, 15.xii.2017, T. Corbin.

**Distribution, habitat and seasonality.** Cool temperate alpine areas from Kanangra-Boyd National Park in central New South Wales south to the Upper Yarra region in central Victoria, with an isolated population in the Otway Ranges (Fig. 26). Adults occur mainly on smooth-barked eucalypts on the main trunks and upper branches. They can be encountered from December to February.





**Figure 27.** *Yoyetta subalpina* sp. nov., (A) male, Cooma (36°20'S 148°13'E), dorsal habitus; (B) male, Cooma, ventral habitus; (C) female, Piccadilly Circus (35°21'S 148°48'E), dorsal habitus; (D), female, Piccadilly Circus, ventral habitus; (E), female, brown form, Piccadilly Circus, dorsal habitus; (F), live male specimen, Apollo Bay (38°45'S 143°33'E), photo by Adrian Tritschler. Scale bar (for preserved specimens) = 10 mm.

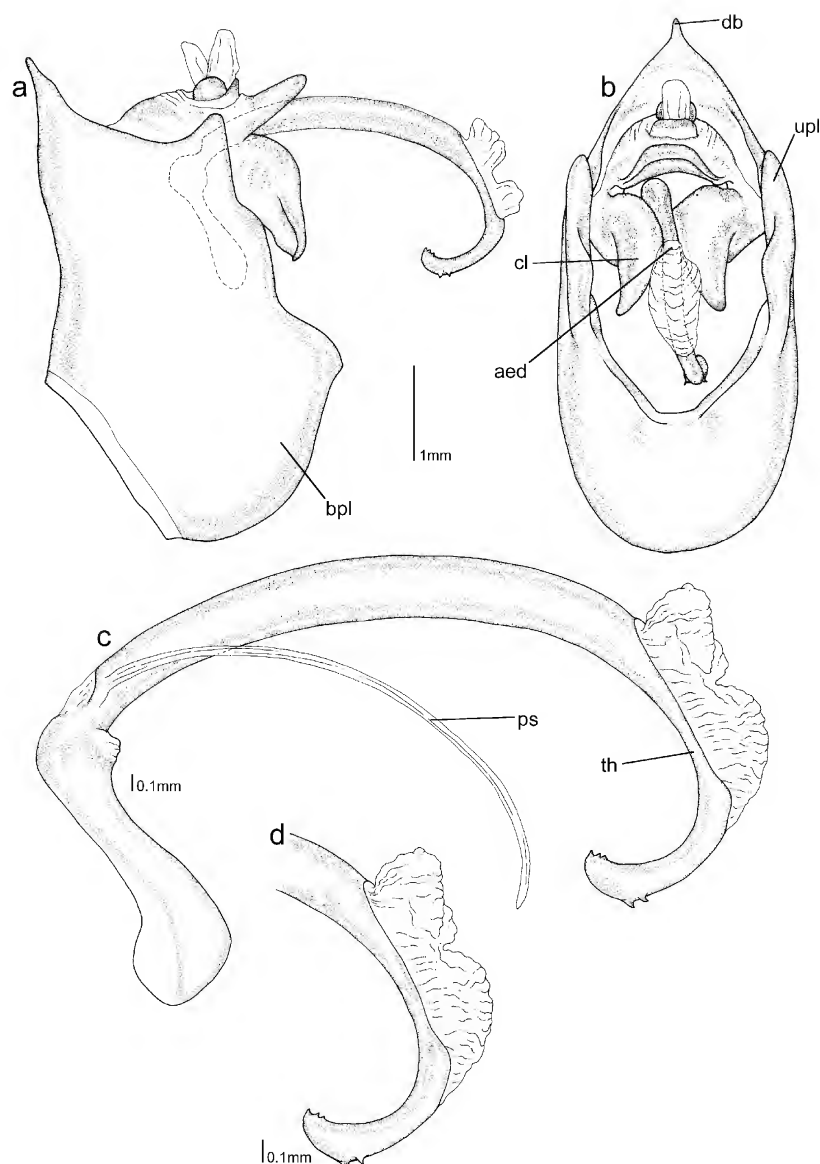
### Description

**Male** (Figs 2E, 3E, 27A–B, 27F, 51G, 52E). *Head* as wide as mesonotum, black, with an ochraceous diamond-shaped marking on midline, posterior to ocelli; ocelli pink to pale; dorsal postclypeus black with central ochraceous triangular marking, apex directed anteriorly; ventral postclypeus black with anterior brown marking on midline, and ochraceous, lateral and posterior margins; anteclypeus black, rostrum brown at base, becoming black at apex, reaching the middle of hind coxae; lora black with ochraceous anterior margin, gena black; eyes dull black; antennae black, supra-antennal plates black, ochraceous around base of pedicel.

*Thorax* predominantly black. Pronotum black, some specimens with brown in fissures; pronotal collar black,

posterior margin ochraceous in some specimens, margins of lateral angles light brown, paranota black, anterior angles ochraceous in some specimens. Mesonotum black; cruciform elevation arms black, lateral depressions tinged brown. Metanotum black.

*Legs.* Coxae mainly black, fore coxae black with proximal ochraceous triangular stripe on posterior surface; mid and hind coxae black; coxal joint and membranes red, basisterna black; trochanters black with central segment orange-red; meracantha small, narrow, orange, black at base, pointed, minimally overlapping opercula; fore femora striped longitudinally orange-red and black, black along base of femoral spines; femoral spines erect, black at base tending dark brown at tips; mid and hind femora black, orange-brown longitudinal



**Figure 28.** *Yoyetta subalpina* sp. nov., illustration of male pygofer and internal genitalia; (a) viewed laterally from the left; (b) viewed ventrally; (c) aedeagus; and (d) apex of theca. Characters as depicted in Fig. 4. Specimen from Piccadilly Circus (35°22'S 148°48'E).

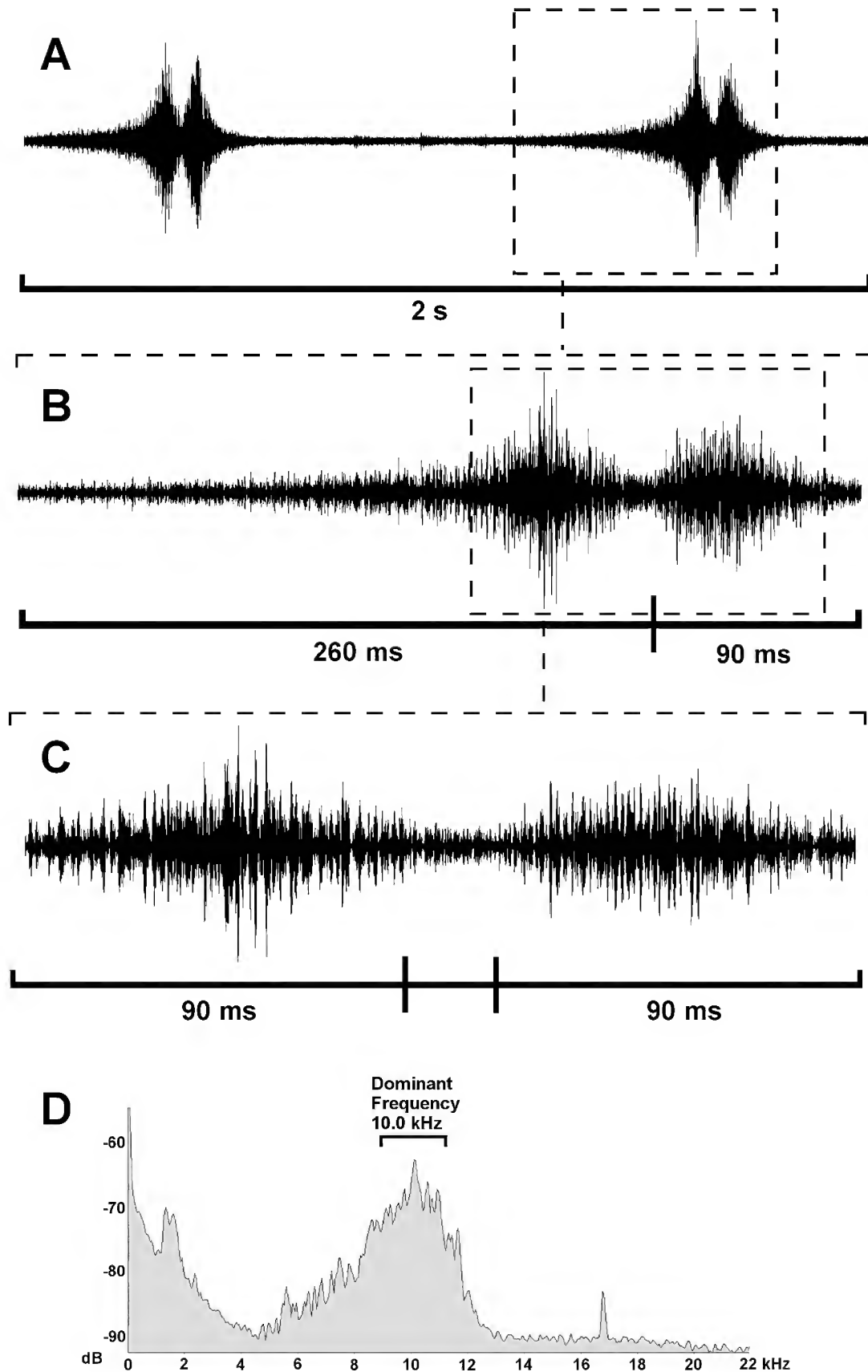
stripe on medial aspect, distal femoral joint orange-red; fore tibiae black, brown at distal tip; mid tibiae black, with medial ochraceous stripe; hind tibiae black proximally ochraceous over distal half; fore tarsi black with brown distal margins; mid and hind tarsi blackish-brown becoming black towards claws; claws dark brown, black at tips.

**Wings** with fore wing costal veins black, browner central rib, becoming ochraceous distally; pterostigma mottled red; basal cell translucent with black anterior border; basal membranes bright orange; other venation dark brown to black; with eight apical cells; hind wing plagas white over entire anal cell 3 and medial third of ac2(v), thin along vein 2A, an irregular grey-black marking at proximal end of jugum, reddish stippling at base of ac2(v), veins 2A and 3A pale, remainder dark brown to black, with six apical cells.

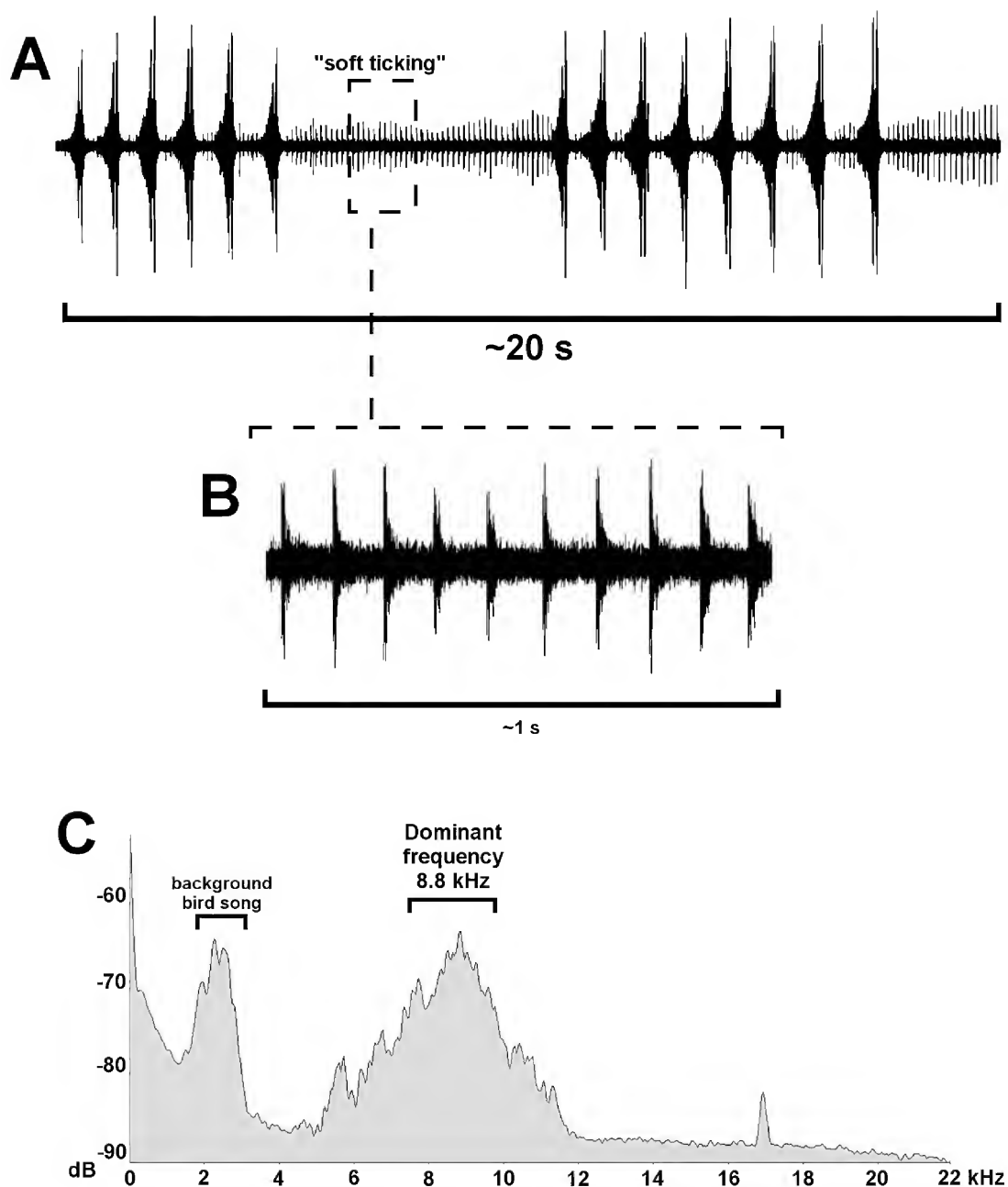
**Opercula** (Fig. 3E) medium, spatulate, following body axis ventrolaterally, depressed centrally, variably black over basal half, orange-brown across remainder, clearly separated.

**Timbals** (Fig. 2E) with five distinct long ribs; long ribs 1–4 extending across surrounding membrane and fused dorsally along basal spur; long rib 5 independent of basal spur, comparatively shorter, extending ventrally across half of membrane; large ridged dome on posterior timbal plate extending across three-quarters of timbal; apodeme pit oval-shaped and conspicuous.

**Abdomen.** Tergite 1 black, with orange-red membranes around timbal cavity; tergite 2 black; tergites 3–7 black with orange posterior margins, extending laterally to epipleurites, increasing on tergites 6–7 on either side of midline; tergite 8 shiny black, with ventral margins orange. Epipleurites with medial black strip, orange over remainder. Sternite II mainly black, with central orange spot; sternite III black medially, becoming orange laterally along posterior margin; sternites IV–VI orange, posterior halves becoming progressively reddish, diffuse black midline markings over anterior two-thirds of each sternite, decreasing posteriorly, sternite VIII dull orange-red, with black pubescence.



**Figure 29.** Typical male calling song structure of *Yoyetta subalpina* sp. nov., illustrated in waveform plots, including (A) two phrases; (B) expanded section from A showing a single phrase with an echeme followed by a long macrosyllable; (C) expanded section from B showing more detail from the echeme and the macrosyllable. The final subfigure (D) is a spectrogram displaying song frequency. The specimen was recorded in the field at Piccadilly Circus (35°22'S 148°48'E) by LWP using RS2 (see *Methods and terminology*).



**Figure 30.** Comparative male calling song structure of *Yoyetta subalpina* sp. nov., illustrated in waveform plots, including (A) a 20 s section containing echemes, interspersed with a “soft ticking” segment; (B) expanded “soft ticking” section (from A) showing 10 syllables. The final subfigure (C) is a spectrogram displaying song frequency. The specimen was recorded in the field at Talleganda (35°37'S 149°30'E) by LWP using RS2 (see *Methods and terminology*).

**Genitalia** (Fig. 28). Pygofer black, upper lobe mainly black, apex brown, basal lobe black; dorsal beak black, dark brown posterior margin, anal styles orange-red. Uncus reddish-brown; in lateral view beak-like and elongated; lobes in ventral view narrow, with rounded lateral termination; claspers clearly divided, short, bulbous, with apices tapering laterally. Aedeagus with pseudoparameres almost extending as far as theca; theca recurved ventrally at around 180° towards apex, with prominent transparent flange along distal margin of recurvature, smooth and broadening to  $> 3\times$  width of theca; remainder of theca is short, with  $< 20\%$  of theca extending apically beyond margin of recurvature; apex blunt, with 2–3 cornuti on ventral surface and several

small cornuti on dorsal side at tip.

**Female** (Fig. 27C–E). *Head*, *thorax* and *abdomen* of dark specimens similar to male. Paler, brown-coloured females apparently occur at a ratio of approximately 1:2.

*Head* in dark specimens, similar to male; in paler specimens mainly brown with black markings around ocelli extending to the supra-antennal plate, brown at anterior margin, black spot at medial border of eye; dorsal postclypeus ochraceous centrally, dark brown laterally; ventral postclypeus black with central ochraceous spot anteriorly; anteclypeus and rostrum similar to male; gena variably ochraceous and black, lateral margins ochraceous posteriorly, black anteriorly.

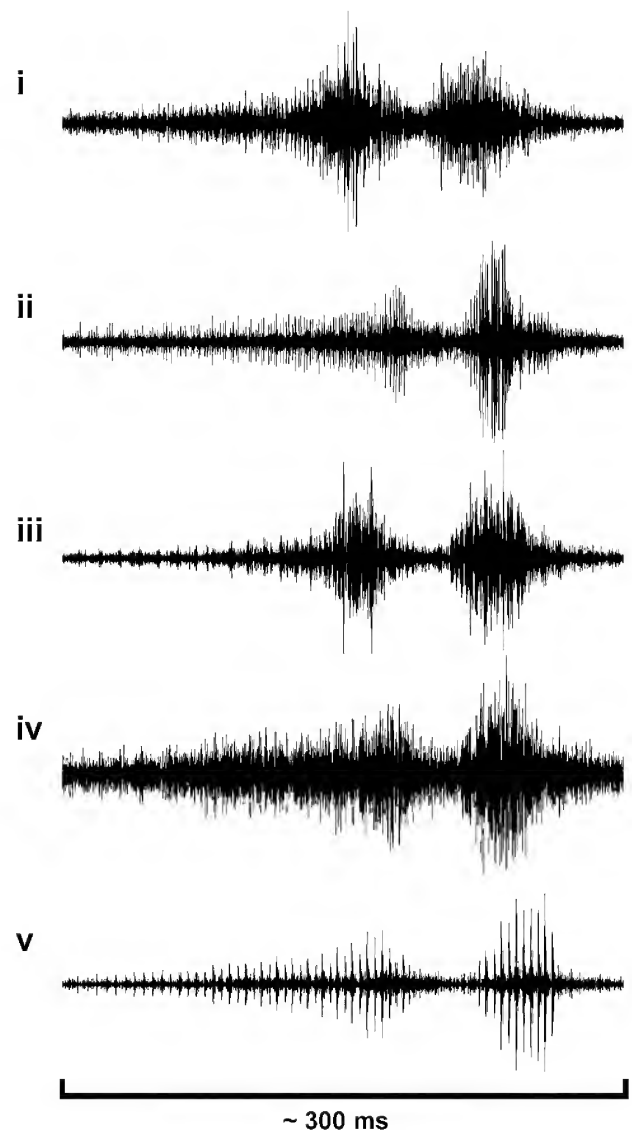
**Thorax** in dark specimens, similar to male. In paler specimens; pronotum with black markings restricted to lateral and posterior margins of a broad ochraceous midline strip over central third, and variably along fissures and lateral margins; pronotal collar brown, with lateral angles black; mesonotum brown with black submedian and lateral sigilla, and a diffuse black central triangular marking with base around scutal depressions, apex directed anteriorly on midline to posterior third of submedian sigilla; cruciform elevation black on central, medial portion and lateral margins, yellow-ochraceous on posterior margins, lateral depressions ochraceous, anterior and posterior depressions dark brown to black; scutal depressions black; metanotum black.

**Abdomen.** Colour variation similar to thorax. On dark specimens, similar to male; abdominal segment 9 black dorsally with ochraceous triangular markings either side of midline, tapering posteriorly, ending midway to dorsal beak, becoming orange laterally, reddish on ventral margin. On brown specimens; tergite 1 black, tergite 2 black on midline, orange merging to black laterally; tergites 3–8 black with orange posterior margins, increasing posteriorly, extending laterally to epipleurites; epipleurites with medial black strip, orange over remainder; sternite II black; sternites III–VI pale brown with midline black marking; sternite VII pale brown with anterior black spot either side of midline; abdominal segment 9 orange-brown with three longitudinal black stripes faint on midline and prominent either side of midline. On all specimens, dorsal beak orange to black at base, black at tip; ovipositor dark brown, becoming black at tip, extending <1 mm beyond apex of abdominal segment 9. Anal styles orange-red; ovipositor sheath dark brown to black.

**Measurements** (in mm; range with mean in parentheses: 10 males, 8 females). Body length: male 25.0–25.1 (25.1); female 24.0–27.0 (26.0). Fore wing length: male 27.7–28.5 (28.1); female 29.4–33.2 (31.9). Head width: male 7.0–7.6 (7.3); female 6.8–7.6 (7.4). Pronotum width: male 6.7–7.4 (7.1); female 6.5–8.4 (7.5). Abdomen width: male 7.4–8.0 (7.7); female 7.5–8.2 (7.8). Ovipositor length 7.6–8.4 (8.0).

**Etymology.** Since most specimens have been collected in cool temperate areas, the species name reflects the climatic situation where this species is typically found.

**Distinguishing features.** *Yoyetta subalpina* sp. nov. displays concentric orange bands on the posterior margins of tergites 3–7; these are absent on *Y. denisoni*, *Y. kershawi* stat. rev., comb. nov., *Y. timothyi* sp. nov. and *Y. grandis* sp. nov. It is readily distinguished from *Y. abdominalis*, *Y. electrica* sp. nov., *Y. spectabilis* sp. nov. and *Y. serrata* sp. nov. by the following combination of characters: (1) large size with body length > 23 mm, (2) lack of symmetrical, orange triangular patterns on tergites 4–7, (3) ovipositors of females extend > 1 mm beyond the posterior abdomen. The forewing basal membranes of *Y. regalis* sp. nov. and *Y. subalpina* sp. nov. are bright orange contrasting with the grey basal membranes of *Y. grandis* sp. nov. in southern Victoria and the dull orange basal membranes of specimens of *Y. grandis* sp. nov. in the Grampians Ranges. Morphologically, male specimens of *Y. subalpina* sp. nov., *Y. verrens* sp. nov. and *Y. regalis* sp. nov. are difficult to differentiate, but the follow features can be used to achieve the correct identification. In *Y. subalpina* sp. nov., the white colouration on the hind wing plaga is



**Figure 31.** Comparative structures of the calling songs for *Yoyetta subalpina* sp. nov., from a range of locations, including: (i) Brindabella Range (35°22'S 148°48'E); (ii) Kanangra Boyd National Park (33°53'S 150°03'E); (iii) Square Rock (35°31'S 148°55'E); (iv) Talleganda National Park (35°37'S 149°30'E); (v) Brown Mtn (36°36'S 149°23'E). Specimens were recorded in the field by LWP using RS2.

bold and extends to cover the entire jugum (cf. in *Y. verrens* sp. nov. the colouration is dull white and restricted along the margins of anal cell 3 and vein 2A). In *Y. subalpina* sp. nov., the sternites are predominantly orange, sometimes with diffuse black spots medially (cf. in *Y. regalis* sp. nov. where the sternites have bold black medial markings that occupy more than half of each sternite). In female specimens, there is substantial colour variation morphologically (orange-brown to black) within species, but the ovipositors extend beyond the abdomen around 1.0 mm for *Y. subalpina* sp. nov., 1–1.5 mm for *Y. regalis* sp. nov., > 1.5 mm for *Y. grandis* sp. nov., and > 2 mm for *Y. verrens* sp. nov. The length of the ovipositor of *Y. regalis* sp. nov. is > 8.8 mm, < 8.6 mm for *Y. subalpina* sp. nov., and > 10.0 mm for *Y. grandis* sp. nov.

**Calling song** (Figs 29–31, 53G). The male calling song of *Y. subalpina* sp. nov. is a simple repetition of phrases, each

comprising an echeme followed by a macrosyllable (Fig. 29A). Closer inspection of the echeme (Fig. 29B) reveals that it comprises a series of macrosyllables that increase in amplitude and coalesce at the highest point of amplification, typically occurring between 0.16 and 0.43 s duration ( $n = 13$ ). A short gap of 0.01–0.04 s duration separates the echeme from the proceeding macrosyllable. The macrosyllable is typically louder than the echeme. It lasts between 0.05 and 0.09 s (Fig. 29C). Gaps of approximately 0.5 s duration separate each phrase. After warming up a little, males sometimes produce soft ticking (syllable trains) in the gaps between each phrase, with longer syllable trains between bouts of phrases (Fig. 30).

Males from most locations across the geographical distribution of this species had a frequency plateau of 8.4–11.1 kHz and a dominant frequency ranging between 9.4 and 10.1 kHz (Fig. 31). The exceptions were males from Talleganda that produced a slightly lower frequency plateau, ranging from 7.1–9.7 kHz with a dominant frequency of 8.4–9.0 kHz ( $n = 4$ ; Fig. 30).

Within the *Y. abdominalis* species group, the calling song of *Y. subalpina* sp. nov. is most similar to *Y. verrens* sp. nov. The main difference in the call of *Y. subalpina* sp. nov. is the addition of a macrosyllable following the echeme, which gives it a distinct two-note signature (cf. the single echeme sweeping notes of *Y. verrens* sp. nov.).

### *Yoyetta serrata* sp. nov.

<http://zoobank.org/NomenclaturalActs/8F5A0B58-EB74-4E08-8C9D-EDFFC425B441>

Figs 2I, 3H, 26, 32–34, 52G, 53J

**Holotype** ♂, 5 km W Nimmitabel, NSW, 36°31'16"S 149°14'08"E, 30.xii.2009, L. W. Popple, Open eucalypt woodland, 518-0001 (AM K.549269). **Paratypes** VICTORIA: 1♀, Gisburn [Gisborne], Vic. 1896, Lyell (ANIC); 1♀, Bemm River, 10.xii.1984, K. L. Dunn (MSM). NEW SOUTH WALES: 1♀, same data as holotype, 518-0012; 1♂, Thredbo, Snowy Mtns, 18 Dec 1999, E. Jeffreys (AM K.307126); 1♂ 1♀, same data as holotype, 518-0005 (♂), 518-0011 (♀) (QM); 3♂♂ 1♀, same data as holotype (518-0003, 518-006, 518-008 [♀], 518-012) (DE); 4♂♂ 3♀♀, same data as holotype, 518-0002, 518-0004, 518-0007, 518-0009, 518-0010, 518-0013; 1♂, Tom Groggin Road, 18 km ESE of Cooma, 36°20'48"S 148°13'57"E, 10.xii.2010, L. W. Popple, 518-0014 (LWP); 13♀♀, Frank Tetley Park, nr Fred Piper Lookout, Brown Mtn, nr Bega, 9.i.1982, M. S. & B. J. Moulds; 1♀, same data, 12.i.1982; 1♀, Jenolan Caves, 23.xii.1973, G. Daniels; 1♂, Yarrangobilly Caves road, Kosciuszko NP, 35°33.258'S 148°30.842'E, 17.i.2011, 1305 m [elev.], K. Hill, D. Marshall, AU.NS.YAX, C. Simon lab voucher, legs in ETOH, body pinned, *Yoyetta* "high pitched", specimen recorded, 11.AU.NS.YAX.06; 1♂, Yarrangobilly Caves road, Kosciuszko NP, 35°43.817'S 148°29.947'E, 1102 m [elev.], 17.i.2011, K. Hill, D. Marshall, AU.NS.YAW, C. Simon lab voucher, legs in ETOH, body pinned, *Yoyetta* "high pitched", specimen recorded, 11.AU.NS.YAW.01; 1♂, Yarrangobilly Caves road, Kosciuszko NP, 35°42.600'S 148°30.386'E, 1286 m [elev.], 16.i.2011, K. Hill, D. Marshall, AU.NS.YAR, C. Simon lab voucher, legs in ETOH, body pinned, *Yoyetta* "high pitched", specimen recorded?, 11.AU.NS.YAR.02 (MSM). AUSTRALIAN CAPITAL TERRITORY: 1♀, Blundells Cr. Rd, Brindabella Rng, ACT, 13.i.1984, J. Lawrence & T. Weir coll., ANIC Database No. 20 005310 (ANIC).

**Distribution, habitat and seasonality.** Temperate areas from the Brindabella Ranges in the Australian Capital Territory, east and south to Gisborne in Victoria (Fig. 26). Adults occur mainly on eucalypts, including smooth-barked species and stringybarks, typically on the upper branches and main trunk. They can be encountered during December and January.

### Description

**Male** (Figs 2I, 3H, 32A,B, 52G). *Head* almost as wide as mesonotum, black, with a central ochraceous fascia posterior to ocelli, being widest at posterior margin, reducing anteriorly, ocelli pink to red; dorsal postclypeus black, with a central brown-ochraceous triangular fascia, apex directed anteriorly; ventral postclypeus black, with ochraceous spot on anterior midline, and dull brown lateral margins; anteclypeus black, rostrum pale brown at base, dark brown to black at apex, extending beyond posterior margins of mid coxae; lora black with ochraceous lateral margin, gena black; eyes dull black; antennae black, supra-antennal plates black, ochraceous ventral area at junction with pedicel.

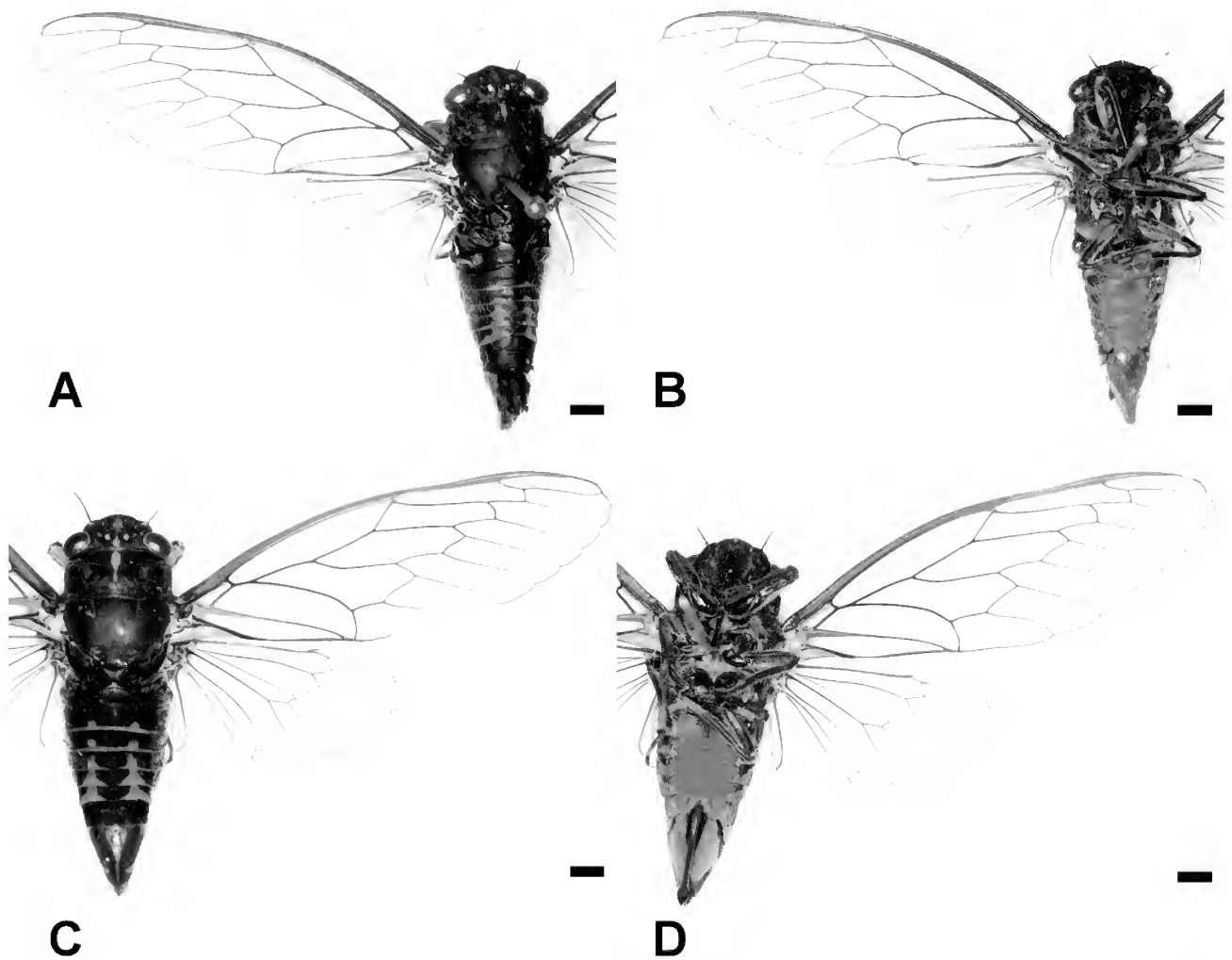
*Thorax* mainly dull black with variable brown patterning. Pronotum black, lateral half or anterior margin brown, with a central ochraceous fascia from behind anterior margin to centre of pronotum, patchy dark brown markings over raised lateral areas of pronotum; paramedial fissures black; lateral fissures variably dark brown; pronotal collar black, margins of lateral angles brown, paranota black. Mesonotum black, parapsidal suture dark brown, scutal depressions and surrounds black; cruciform elevation black. Metanotum black.

*Legs.* Coxae mainly black, fore coxae black, longitudinal red lateral stripe; mid and hind coxae black; coxal membranes orange-red, basisterna black; katapisterna black with posterior half brown; meracantha small, narrow, proximal half black, pale cream distally, pointed, marginally overlapping opercula; trochanters black, orange-brown laterally; fore femora striped red-brown, black longitudinal markings around base of femoral spines femoral spines erect, black; mid femora black medially, red-brown strips over remainder; hind femora orange-brown with black posterior stripe and black distal markings, distal femoral joint orange-red; fore tibiae black; mid tibia black with proximal ochraceous spot on lateral border; hind tibia proximally black, becoming brown towards tarsi; fore and mid tarsi black; hind tarsi orange-brown becoming black towards claws; spines orange-brown; claws dark brown, black at tips.

*Wings* with fore wing costal veins black anteriorly, reddish-brown central rib, becoming brown distally, pterostigma mottled red, arculus black, brown at base; basal cell pale, translucent, black anterior border; basal membranes pale, whitish-grey; other veins dark brown to black, proximal segment of vein CuA pale grey, becoming brown distally, with eight apical cells; hind wing plaga white over jugum and vein 3A, thin along vein 2A, subcostal vein pale, other veins brown, with six apical cells.

*Opercula* (Fig. 3H) medium, spatulate, following body axis ventrolaterally, depressed centrally, black at base, tending variably pale grey to dark grey-brown across remainder with reddish posterior border in some specimens, clearly separated.

*Timbals* (Fig. 2I) with five distinct long ribs; long ribs 1–4 extending across surrounding membrane and fused dorsally along basal spur; long rib 5 independent of basal spur, comparatively shorter, extending ventrally across half of membrane; large ridged dome on posterior timbal plate extending across two-thirds of timbal; apodeme pit oval-shaped and conspicuous.



**Figure 32.** *Yoyetta serrata* sp. nov., (A) male, Nimmitabel (36°31'S 149°14'E), dorsal habitus; (B) male, Nimmitabel, ventral habitus; (C) female, Nimmitabel, dorsal habitus; (D), female, Nimmitabel, ventral habitus. Scale bars = 2 mm.

**Abdomen** with tergites 1 and 2 black; tergites 3–7 black with orange posterior margins, extending laterally to epipleurites, progressively increasing on either side of midline to reach anterior borders of tergites 6–7; tergite 8 black, with red spot located posterolaterally. Epipleurites 1–3 mainly black with orange lateral margins; epipleurites 4–6 mainly orange. Sternite II black; sternite III black medially, orange-red over central third posterior to timbal cavity, black laterally; sternites IV–IV orange, with diffuse black areas anteriorly; sternites V and VI orange; sternite VII orange, red posteriorly; sternite VIII fiery red, with brownish pubescence (Fig. 52G).

**Genitalia** (Fig. 33). Pygofer shiny black, upper lobe mainly black with dark brown posterior margin; basal lobe ochraceous; dorsal beak black, anal styles orange. Uncus black with posterior mid-section orange, in lateral view beak-like and stumpy; lobes in ventral view short and narrow, with rounded lateral termination; claspers clearly divided, short, pear-shaped, with apices gradually tapering laterally. Aedeagus with pseudoparameres extending around half the length of theca; theca recurved ventrally at 120° towards apex, with prominent transparent flange projecting from dorsal margin of recurvature, thin flange continuing almost to apex of theca; apex short, sclerotized, with 4–6 prominent cornuti on ventral surface.

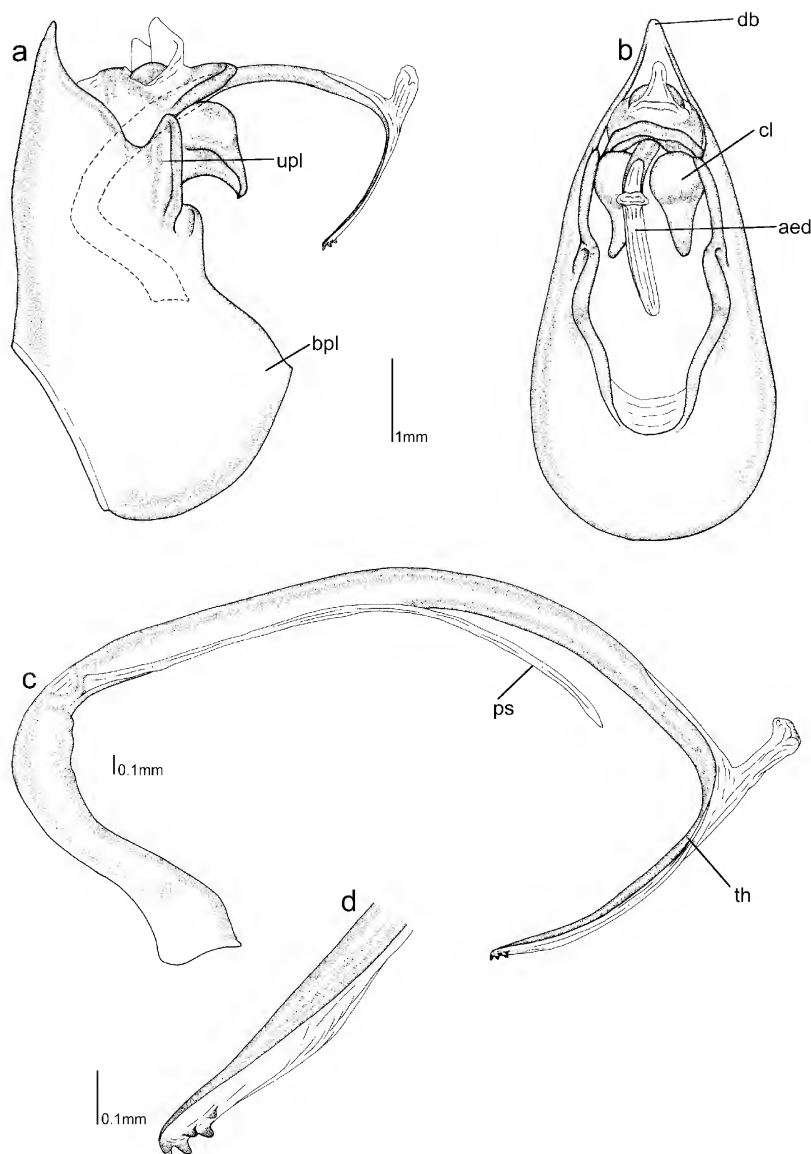
**Female** (Fig. 32C,D). *Head* and *thorax* similar to male.

**Abdomen.** Tergites similar to male; tergite 8 with an orange spot on each posterolateral side. Sternites I and II black, posterior margins ochraceous; sternites III–VII orange-red with midline black marking decreasing to sternite IV. Abdominal segment 9 black centrally, with small orange triangular markings either side of midline, decreasing posteriorly, black dorsally and laterally over anterior third, with posterior reddish spot, ventral aspect orange-red, black posteriorly. Dorsal beak black; ovipositor dark brown, becoming black at tip, not extending beyond apex of abdominal segment 9. Anal styles orange-red; ovipositor sheath black, paler brown ventrally, gonocoxites black laterally, ochraceous along midline.

**Measurements** (in mm; range with mean in parentheses: 8 males, 6 females).

**Body length:** male 19.0–22.9 (21.7); female 24.1–25.1 (24.6). **Fore wing length:** male 23.8–26.8 (25.8); female 28.3–31.4 (29.6). **Head width:** male 5.4–6.4 (5.9); female 6.6–7.3 (7.0). **Pronotum width:** male 5.4–6.5 (5.9); female 6.8–7.7 (7.3). **Abdomen width:** male 5.4–6.4 (6.1); female 6.5–8.0 (7.4). **Ovipositor length** 6.2–7.7 (7.1).





**Figure 33.** *Yoyetta serrata* sp. nov., illustration of male pygofer and internal genitalia; (a) viewed laterally from the left; (b) viewed ventrally; (c) aedeagus; and (d) apex of theca. Characters as depicted in Fig. 4. Specimen from Nimmitabel (36°31'S 149°14'E).

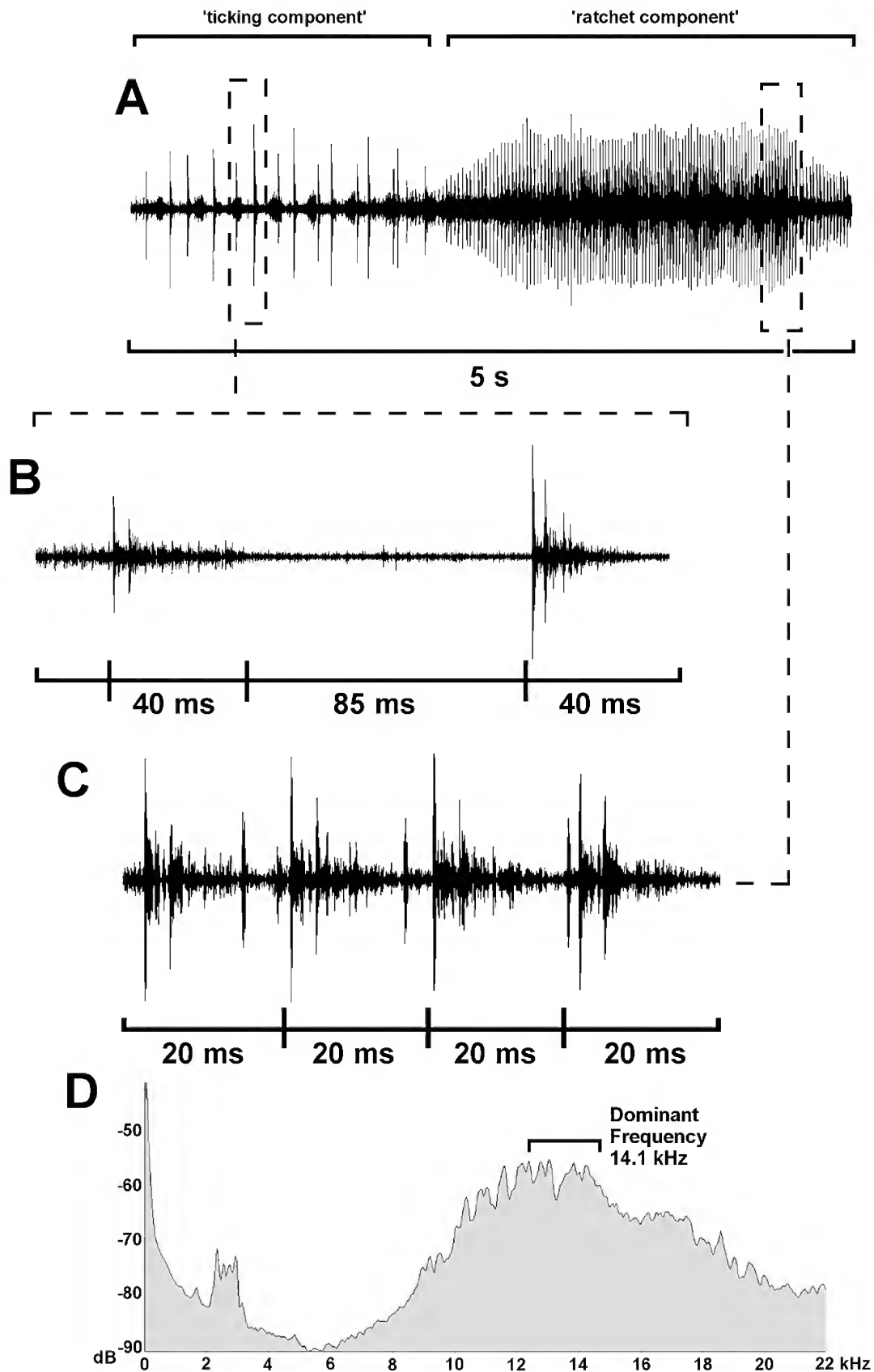
**Etymology.** From the Latin word “*serratus*” meaning serrated, referring to the sharp-edged yellow markings on the lateral edges of the abdomen of this species.

**Distinguishing features.** Within the *Y. abdominalis* species group, *Y. serrata* sp. nov. is most similar in appearance to *Y. abdominalis* and *Y. spectabilis* sp. nov. The following combination of characters distinguishes *Y. serrata* sp. nov. from all other species in the *Y. abdominalis* species group: (1) Fore wings with distinct, pale grey-white basal membranes, (2) body length < 23 mm, (3) female ovipositor does not extend noticeably beyond abdominal segment 9, (4) pubescence (when present) black, (5) tergite 8 almost entirely black, without contrasting markings, (6) tergites 5–7 back with yellow markings (not mainly orange), (7) opercula pale grey to dark grey-brown.

**Calling song** (Figs 34, 53J). Two song modes typify the calling song of male *Y. serrata* sp. nov. Based on available recordings ( $n = 11$ ), One of the modes (the ratchet mode) is a long echeme, which is composed of a series

of closely emitted, discrete syllables (Fig. 34A,C). On commencement, the echeme increases in amplitude and is sustained for several seconds before diminishing towards the end (Fig. 34). For recordings made in southern New South Wales and the Australian Capital Territory, the single echeme comprises between 32 and 121 syllables over a period between 0.38 and > 5.0 s duration. A small period of silence from 0.011–0.372 s duration signals the end of the echeme and this mode. The other mode (ticking) is formed by a repeated series of 4–13 syllables, each being a doublet pulse of 0.006–0.021 s duration ( $n = 11$ ). A gap of 0.167–0.348 s duration separates each syllable (Fig. 34A,B). The highest amplitude frequency plateau for this species is 9.6–16.4 kHz, with a dominant frequency of 12.5–14.7 kHz (Fig. 34D).

There are no other known species in the *Y. abdominalis* species group that produce a song similar to *Y. serrata* sp. nov. Indeed, despite being similar in appearance, there are no clear similarities between the songs of *Y. abdominalis*, *Y. serrata* sp. nov. and *Y. spectabilis* sp. nov.



**Figure 34.** Typical male calling song structure of *Yoyetta serrata* sp. nov. illustrated in waveform plots, including (A) a complete rendition of one bout of the "ticking" mode, followed by the "ratchet" mode (further detail in text); (B) expanded section from A showing two syllables from the ticking mode; (C) expanded section from A showing four discrete syllables within the long echeme. The final subfigure (D) is a spectrogram displaying song frequency. The specimen was recorded in the field at Nimmitabel (36°31'S 149°14'E) by LWP using RS2 (see *Methods and terminology*).

*Yoyetta grandis* sp. nov.

<http://zoobank.org/NomenclaturalActs/6C0DD78E-345A-4830-9F64-C947523B23B9>

Figs 2L, 3J, 26, 35–37, 52H, 53E

**Holotype** ♂, Meredith, VIC, 12–13.ii.1959, A. N. Burns (HEM2054) (MMV). **Paratypes** VICTORIA: 1♂, Lakes Entrance, W. W. Froggatt collection, ex. National Museum of Victoria; 1♂, Mt Beauty dist. VIC, i.1979, P. Polile for W. N. B. Quick (ANIC); 2♂♂, Mt Buffalo, VIC, 36°43'S 146°46'E, 29.xii.1951 (HEM2603–04); 1♂, Walhalla, VIC, 37°57'S 146°27'E, 1.i.1937 (HEM2606); 1♂, Kinglake, VIC, 37°32'S 145°20'E, xii.1927 (HEM2607); 1♀, Bogong, VIC, 36°48'S 147°13'E, no date (HEM2619); 1♂ 1♀, Moggs Creek, VIC, 38°27'S 143°59'E, 27.xii.1981 (HEM2621–22); 3♂♂ 1♀, Mt Eccles, VIC, 38°22'S 145°59'E, xii.1961 (HEM2626–29); 1♀, Pyrenees Range W of Avoca, VIC, 37°05'S 143°16'E, 10.xii.1970, (HEM2630) (MMV); 1♂, same location, 1.xii.2006, D. Marshall & K. Hill (06.AU.VI.GRL); 1♂, Healesville, 25.i.1992, C. Rojewski; 1♀, Erskine Falls nr Lorne, 18.ii.1984, G. Theischinger; 1♀, Otway State Forest, 17.i.1990, G. & J. Burns; 2♂♂ 5♀♀, Warburton, 7.i.2011, S. Smith; 2♂♂, Brisbane Ranges, 14–24.i.1999, Stephen Smith; 6♂♂, same data, 14.ii.2004, S. Smith; 1♂, 12 km SE of Healesville, Yarra Ranges Nat. Pk, 15.i.1999; 1♂, Don Rd, near Healesville, 26.xii.1994, Stephen Smith; 1♂, Anakie, 16.xii.2003, S. K. Smith; 2♂♂ 1♀, Charley Ck, 5 km N of Ferguson, 1.i.1998, Stephen Smith; 1♀, Starvation Ck township, Little Peninsula Tunnel Picnic Ground, 12.xii.2007, S. Smith; 1♂, same data, 14.xii.2007; 3♀♀, same data, 27.xii.2007; 1♂ 2♀♀, Starvation Ck. Rd, McMahons Creek township, 37°45'S 145°51'E, 23.xii.2007; 1♀, Don Gap nr Warburton, 37°41'S 145°36'E, 16.i.2008, S. Smith; 1♂, Healesville, 25.i.1992, C. Rojewski; 1♀, Eerskine Falls nr Lorne, 18.ii.1984, G. Theischinger; 1♀, Otway State Forest, 17.i.1990, G. & J. Burns 1♂, same location, 15.i.2011, S. Smith; 1♂, Healesville, 25.i.1992, C. Rojewski; 1♀, Erskine Falls nr Lorne, 18.ii.1984, G. Theischinger; 1♀, Otway State Forest, 17.i.1990, G. & J. Burns; 1♂, Reid's Lookout, W of Halls Gap, Grampians National Park, 1.xii.2006, 37°08.971'S 142°26.808'E, 717 m, D. Marshall, K. Hill, C. Simon lab voucher, legs in ETOH, body pinned, 06.AU.VI.GRL.01, *Yoyetta* "slow tucker" (MSM); 5♂♂ 6♀♀, 1 km SE of Forrest, Otway Ranges, 38°31'25"S 143°43'19"E, 5.ii.15, S. Emery & T. Corbin; 1♂, Kinglake-Glenburn Rd, Kinglake, 32°28'11"S 145°23'41"E, 17.xii.2016, S. Emery & T. Corbin; 4♂♂ 8♀♀, McMahons Creek Rd, 37°42'05"S 145°50'06"E, 26.i.2017, N., C. & D. Emery; 1♀, Kallista, 37°53'52"S 145°22'10"E, 26.xii.2018, S. Emery & T. Corbin (emerging); 3♂♂ 1♀, Grampians Nat Pk., Reed Lookout, 7 km W Hall's Gap, 2.i.2000, F. Douglas (DE); 1♂ 1♀, same location, 2.ii.2000, F. Douglas (FD). AUSTRALIAN CAPITAL TERRITORY: 1♂ 1♀, Warks Rd, Brindabella Range, 35°19'59"S 148°49'49"E, 7.i.2011, L. W. Popple, 720-0001 (♂), 720-0002 (♀) (LWP). NEW SOUTH WALES: 1♂, Yarrangobilly Caves road, Kosciuszko NP, 35°42.600'S 148°30.386'E, 1286 m [elev.], 16.i.2011, K. Hill, D. Marshall, AU.NS.YAR, C. Simon lab voucher, legs in ETOH, body pinned, *Yoyetta* sp., 11.AU.NS.YAR.01 (MSM).

**Distribution, habitat and seasonality.** Tall open forest in the Brindabella Ranges of the Australian Capital Territory south through much of eastern Victoria, particularly north east of the Dandenong Ranges, with additional populations in the Otway and Grampians Ranges (Fig. 25). Adults are present during December and January. Males tend to remain on the main trunks and upper branches of eucalypts (section *Maidenaria*), while females are generally found within 5 m of the forest floor. Very large seasonal populations of this species have been observed over multiple years in succession and are considered likely to be a frequent occurrence.

### Description

**Male** (Figs 2L, 3J, 35A,B,E,F, 52H). *Head* as wide as mesonotum, with a thin ochraceous fascia on the midline posterior to ocelli, not reaching posterior margin; ocelli pink; dorsal side of postclypeus black with central ochraceous triangular marking, apex directed anteriorly; ventral side of postclypeus black with anterior brown marking on midline, black transverse grooves, lateral borders ochraceous; anteclypeus black, rostrum black at base, brown centrally, becoming black at apex, reaching the posterior margin of mid coxae; lora black with ochraceous anterior spot, gena

black; eyes red in live specimens, grey-white in preserved specimens; antennae black, supra-antennal plates black, brown at base of pedicel.

*Thorax* predominantly black. Pronotum black, with a thin brown line along anterior midline; pronotal collar black, paranota black. Mesonotum black; cruciform elevation arms black, posterolateral arms and lateral depressions brown. Metanotum black.

*Legs.* Coxae mainly black, fore coxae black with lateral red stripe; mid and hind coxae black; coxal membranes red; basisterna black; meracanthus small, narrow, orange, black at base, pointed, rounded at tip, overlapping one-third of opercula; trochanters black with central segment orange-red; fore femora striped longitudinally orange-red and black, black along base of femoral spines, femoral spines erect, black; mid and hind femora black, orange-brown longitudinal stripe on medial and lateral aspects; distal femoral joint orange-red; fore tibiae black, brown at distal tip; mid tibiae black, with medial ochraceous stripe; hind tibiae black proximally, ochraceous over distal half; fore tarsi black with brown distal margins; mid and hind tarsi blackish-brown becoming black towards claws; claws dark brown, black at tips.

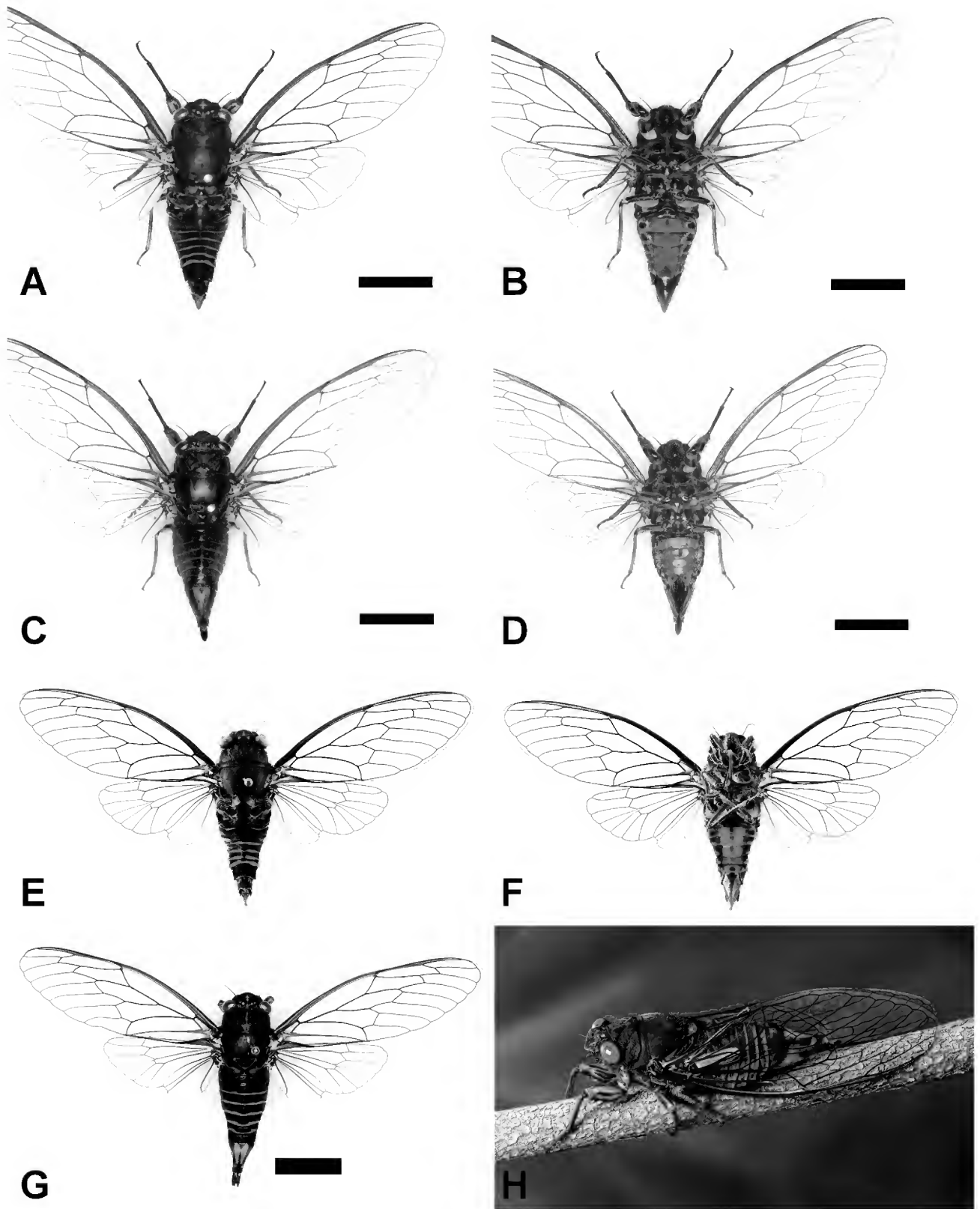
*Wings* with fore wing costal veins black, browner posteriorly, becoming brown distally, pterostigma mottled dark red, basal cell yellowish, translucent, black anterior border, brown spot in arculus, basal membranes grey, pale orange on Grampians specimens, other veins dark brown to black, with eight apical cells; hind wing plagas white over entire anal cell 3 and medial quarter and base of ac2(v), thin along vein 2A, veins 2A and 3A pale brown, remainder black, with six apical cells.

*Opercula* (Fig. 3J) medium, spatulate, following body axis ventrolaterally, black over basal third, pale cream across remainder, clearly separated.

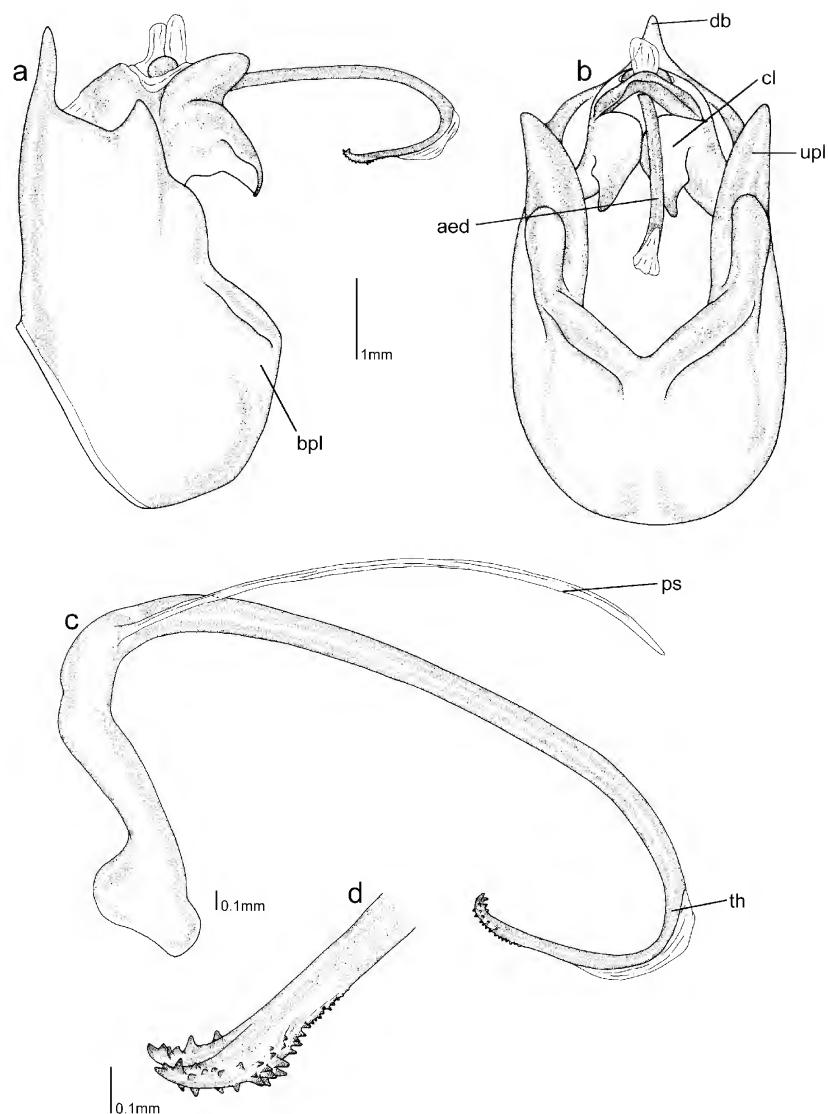
*Timbals* (Fig. 2L) with five distinct long ribs; long ribs 1–3 extending across surrounding membrane and fused dorsally along basal spur, long rib 3 conspicuously narrowing over lateral third; long rib 5 independent of basal spur, comparatively shorter, extending ventrally across half of membrane; large ridged dome on posterior timbal plate extending across two-thirds of timbal; apodeme pit oval-shaped and conspicuous.

*Abdomen* with tergite 1 black, ochraceous around medial margin of timbal cavity; tergite 2 black; tergites 3–7 black with orange posterior margins, extending laterally to epipleurites, increasing on tergites 6–7 on either side of midline, intersegmental membranes orange; tergite 8 entirely black. Epipleurites 3–4 black anteriorly, orange over remainder; epipleurites 5–7 orange. Sternite II black; sternite III black, with ochraceous anterior margin around timbal cavity; sternite IV black anteriorly, stippled black orange posteriorly; sternites V–VI orange, diffuse black midline markings prominent over posterior midline of sternite VI; sternite VII orange with central black spot; sternite VIII black, dark brown posteriorly, with black pubescence (Fig. 52H).

*Genitalia* (Fig. 36). Pygofer black, dorsal beak black, dark brown posterior margins, upper lobe developed, rounded, black, orange on ventral aspect, basal lobe, rudimentary, black, anal styles reddish. Uncus mainly black; lateral



**Figure 35.** *Yoyetta grandis* sp. nov., (A) male, Grampians National Park (37°09'S 142°27'E) dorsal habitus; (B) male, Grampians National Park, ventral habitus; (C) female, Grampians National Park, dorsal habitus; (D) female, Grampians National Park, ventral habitus; (E) male, Brindabella Range, (35°19'S 148°49'E) dorsal habitus; (F) male Brindabella Range, ventral habitus; (G) female, McMahons Creek (37°42'S 145°50'E) dorsal habitus; (H) female, McMahons Creek, live specimen (Photo by NJE). Scale bars = 10 mm.



**Figure 36.** *Yoyetta grandis* sp. nov., illustration of male pygofer and internal genitalia; (a) viewed laterally from the left; (b) viewed ventrally; (c) aedeagus; and (d) apex of theca. Characters as depicted in Fig. 4. Specimen from McMahon's Creek (37°42'S 145°50'E).

process beak-like and stumpy; lobes in ventral view bulbous, short, with rounded anterior termination; claspers apposed posteriorly, clearly divided anteriorly, short, with apices reducing and rounded laterally. Aedeagus brown, with pseudoparameres extending around two-thirds the length of theca; theca recurved ventrally at 180° towards apex, with transparent flange along outer margin of distal half of recurvature, smooth, around diameter of theca; apex brownish, sclerotized, bifurcate, branches closely applied, directed dorsolaterally with prominent cornuti over entire surface.

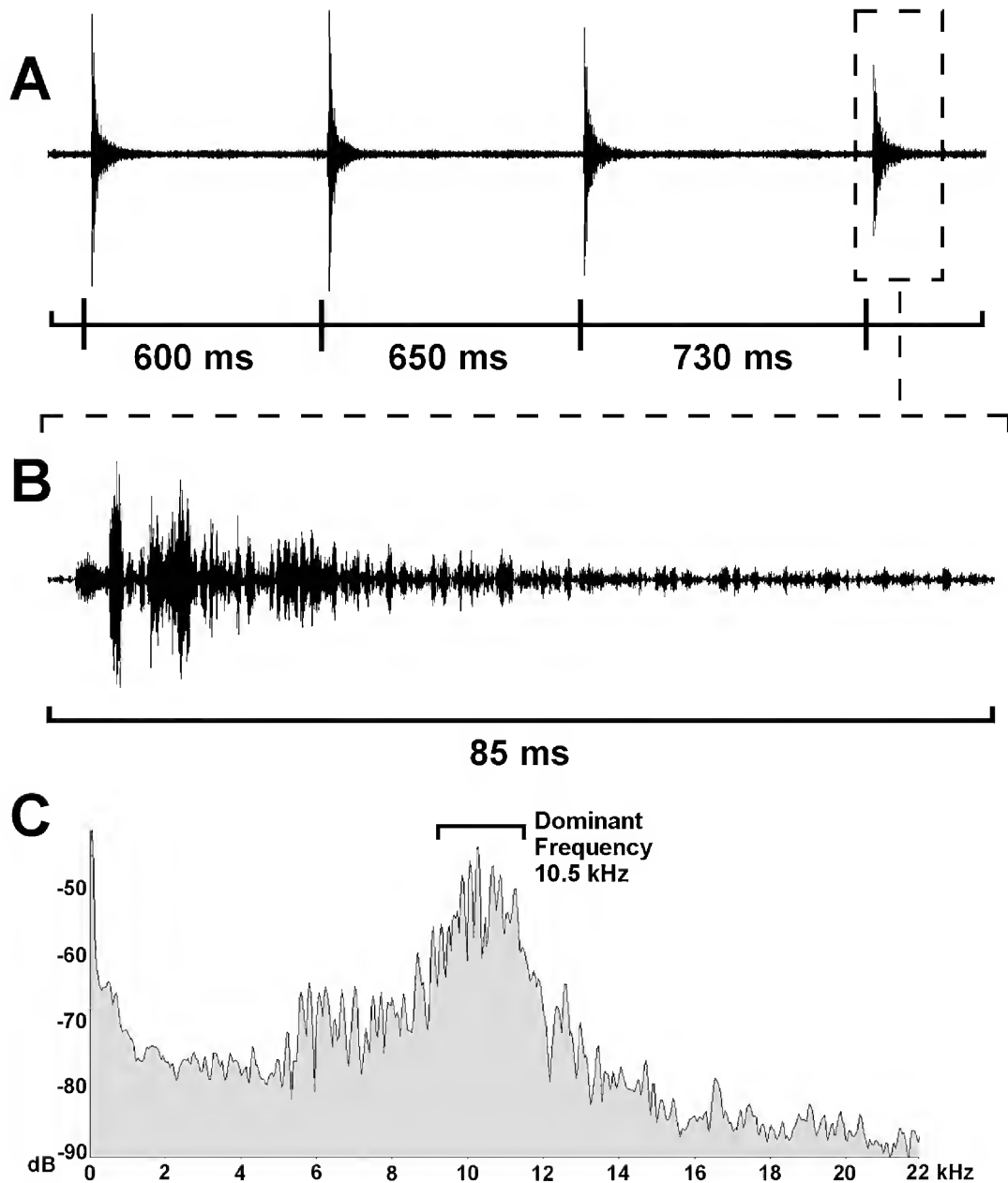
**Female** (Fig. 35C–D, G–H). *Head* similar to male, with additional brown spot midway between ocelli and eye, ochraceous-brown markings on dorsal and anterior postclypeus more pronounced, lateral areas dark brown, supra-antennal plate black with distinct ochraceous anterior margin adjacent to pedicel.

*Thorax* predominantly black (similar to male), except in pale specimens, which exhibit extensive brown colouration

on the pronotum and mesonotum (with contrasting black sigilla); metanotum brown posterior to cruciform elevation.

*Abdomen* similar to male. Tergites 4–7 with posterior annular orange markings less pronounced than males; tergite 8 black. Epipleurites mainly black, orange posteriorly. Sternites I–VII similar to male; sternite VII orange with 2 distinct black spots either side of midline; abdominal segment 9 black with ochraceous-orange longitudinal triangles either side of midline, tapering posteriorly, and broad ochraceous-orange area over middle third of lateral surface; dorsal beak black. Ovipositor brown, black at tip, extending approximately 1.5 mm beyond apex of abdominal segment 9. Anal styles dull brown, ovipositor sheath dark brown to black.

**Measurements** (in mm; range with mean in parentheses: 10 males, 12 females). Body length: male 24.8–26.8 (25.6); female 26.7–31.6 (29.6). Fore wing length: male 27.9–30.8 (29.6); female 28.1–34.5 (32.3). Head width: male 6.5–7.5



**Figure 37.** Male calling song structure of *Yoyetta grandis* sp. nov., illustrated in waveform plots, including (A) four discrete macrosyllables, (B) an expanded section (from A) to illustrate the detailed structure of a single macrosyllable. The final subfigure (C) is a spectrogram displaying song frequency. The specimen was recorded in the field at Birdwood (34°50'S 138°57'E) by David Marshall on 29.xi.2006 using RS4 (see *Methods and terminology*).

(7.0); female 6.6–7.9 (7.4). Pronotum width: male 6.4–7.5 (6.9); female 6.4–7.8 (7.3). Abdomen width: male 6.3–7.8 (7.2); female 6.9–8.1 (7.6). Ovipositor length 10.0–11.5 (10.6).

**Distinguishing features.** Within the *Y. abdominalis* species group, *Y. grandis* sp. nov. is most similar in appearance to *Y. electrica* sp. nov., *Y. regalis* sp. nov., *Y. subalpina* sp. nov. and *Y. verrens* sp. nov. Each of these species has black tergites with contrasting, narrow orange bands on the posterior edge. The following characters, in combination, can be used to distinguish *Y. grandis* sp. nov. from these species: (1) eyes red (live or freshly-preserved specimens, fading to dark pink or grey), (2) fore wing basal membranes grey (or

pale orange in Grampians specimens), (3) sternite VIII (or ventral abdominal segment in female specimens) dark brown (not orange, orange-brown or brown), (4) ovipositor extends 1.5 mm beyond apex of abdominal segment 9. Specimens of this species in collections have previously been attributed *Y. denisoni* and *Y. aeade*. However adults can be easily distinguished from *Y. denisoni* and its relatives (*Y. kershawi* stat. rev., comb. nov. and *Y. timothyi* sp. nov.). The female of *Y. grandis* sp. nov. bears a superficial resemblance to *Y. aeade*; however, the former species is much larger (fore wing length > 27 mm) and *Y. aeade* is known only from the Adelaide region in South Australia.

**Calling song** (Figs 37, 53E). *Yoyetta grandis* sp. nov. males call when stationary and during flight. The calling song contains a simple series of sharp, single macrosyllables or short echemes. Based on available recordings from Brindabella ( $n = 5$ ) and a recording supplied by David Marshall from Birdwood, each macrosyllable or short echeme is between 0.085 and 0.135 s duration (Fig. 36). The intervals between these range from 0.566–0.708 s duration. The highest frequency plateau of this song ranges from 8.4–11.4 kHz, with a dominant frequency of 9.5–10.5 kHz. When males are stationary, they occasionally produce a longer echeme before a bout of typical echemes (illustrated in Fig. 53E).

Despite its simplicity, the calling of *Y. grandis* sp. nov. is distinctive and unique amongst its relatives in the *Y. abdominalis* species group.

## *Yoyetta aaede* (Walker, 1850)

Figs 2J, 3K, 38–41, 53H

*Cicada aaede* Walker, 1850: 181.

*Melampsalta aaede*.—Stal, 1862: 484; Goding and Froggat, 1904: 648; Distant, 1906: 170; Ashton, 1914: 355; Burns, 1957: 645.

*Cicadetta aaede*.—Moulds, 1990: 143; Moulds and Cowan, 2002: 24.

*Yoyetta aaede*.—Moulds, 2012: 237; Sanborn, 2014: 553.

**Material examined.** SOUTH AUSTRALIA: *Holotype* female, [Handwritten] “A. H. Davis, Adelaide”/[Typed] “Ent. Club, 44-12”, “129. CICADA AÆDE”/[round label, green border] “Type” (NHM). 3♂♂ *Melampsalta umbrovariegata*, Mt Lofty Ra. very numerous [1 “exceptionally numerous”], 7.12. [19]05, Davidson, gum, SAMA Database No. 20-014565–67; 2♂♂, Morphet Vale, Dec 1889, J. W. Mellor, Mellor Coll., via Capt. S. A., White Coll. (SAM); 3♂♂ 3♀♀, Hazelwood Park, Adelaide, 34°56'12"S 138°39'25"E, 19.xi.2018, J. Fander (EME 0782 004–9) (LWP); 1♂ 2♀♀, same location, 19.xi.2018, J. Fander (DNA 84–6, EME 0782 001–3); 4♂♂ 8♀♀, same location, 19.xi.2018, J. Fander (EME 0782 010–021, females 010–017); 13♂♂ 10♀♀, same location, 21.xi.2018, B. Parslow (EME 0782 018–045, females 036–045) (DE); 18♂♂ 42♀♀, same location, 20.xi.2018, B. Parslow & M. Gemmell (SAM).

**Distribution, habitat and seasonality.** Known only from “Adelaide” (the type locality), as well as from Mt Lofty Range and Morphet Vale (Fig. 41). It has been found in parkland and most likely also occurs in remnant and regrowth eucalypt forest, with records indicating that adults appear in ephemeral mass emergences. Adults have been collected during November and December.

## Description

**Male** (Figs 2J, 3K, 38A–B, 38F, 39–40). *Head* approximately as wide as mesonotum; dorsally mainly black, with a small, tear-shaped, brown marking posterior to ocelli, reducing anteriorly; ocelli pink; dorsal postclypeus dark brown with ochraceous brown midline surrounded by black and with black anterior margin; ventral postclypeus black, with pale pinkish-brown lateral margins; frons black; anteclypeus black; rostrum brown at base, black posteriorly, apex reaching middle of hind coxae; lora black; eyes rose-red; antennae black, each with a brown spot anterior of pedicel; supra-antennal plates black.

*Thorax* predominantly black. Pronotum mainly black with pale yellow-brown stripe on anterior half of midline, ridges between lateral and paramedian fissures variably black-brown to black; pronotal collar mainly black, dark brown on lateral angles. Mesonotum black; cruciform elevation with lateral depressions pale yellow; metanotum dark brown to black.

*Legs.* Coxae dark brown to black, joints pale brown to orange-brown; meracantha narrow, pale grey, black at base, pointed, overlapping opercula; trochanters dark brown, black ventrally; fore femora mainly dark brown, pale brown on anterior outer sides and at joints; femoral spines erect, dark brown at base, yellow-brown at tips; mid and hind femora dark brown; fore and mid tibiae dark brown; hind tibiae dark brown at base, pale brown over remainder; fore and mid tarsi brown to dark brown; hind tarsi pale brown; claws dark brown.

*Wings* with fore wing costal veins dark brown, paler distally; subcostal veins brown to pale brown; pterostigma mottled reddish-brown; basal cell transparent; basal membranes white; veins CuP+1A pale yellow-brown; other veins mainly dark brown to black to intermodal line, paler posteriorly; with eight apical cells; prominent hind wing plagas white over entire anal cell 3 and vein 3A, extending to base of vein 2A, with six apical cells.

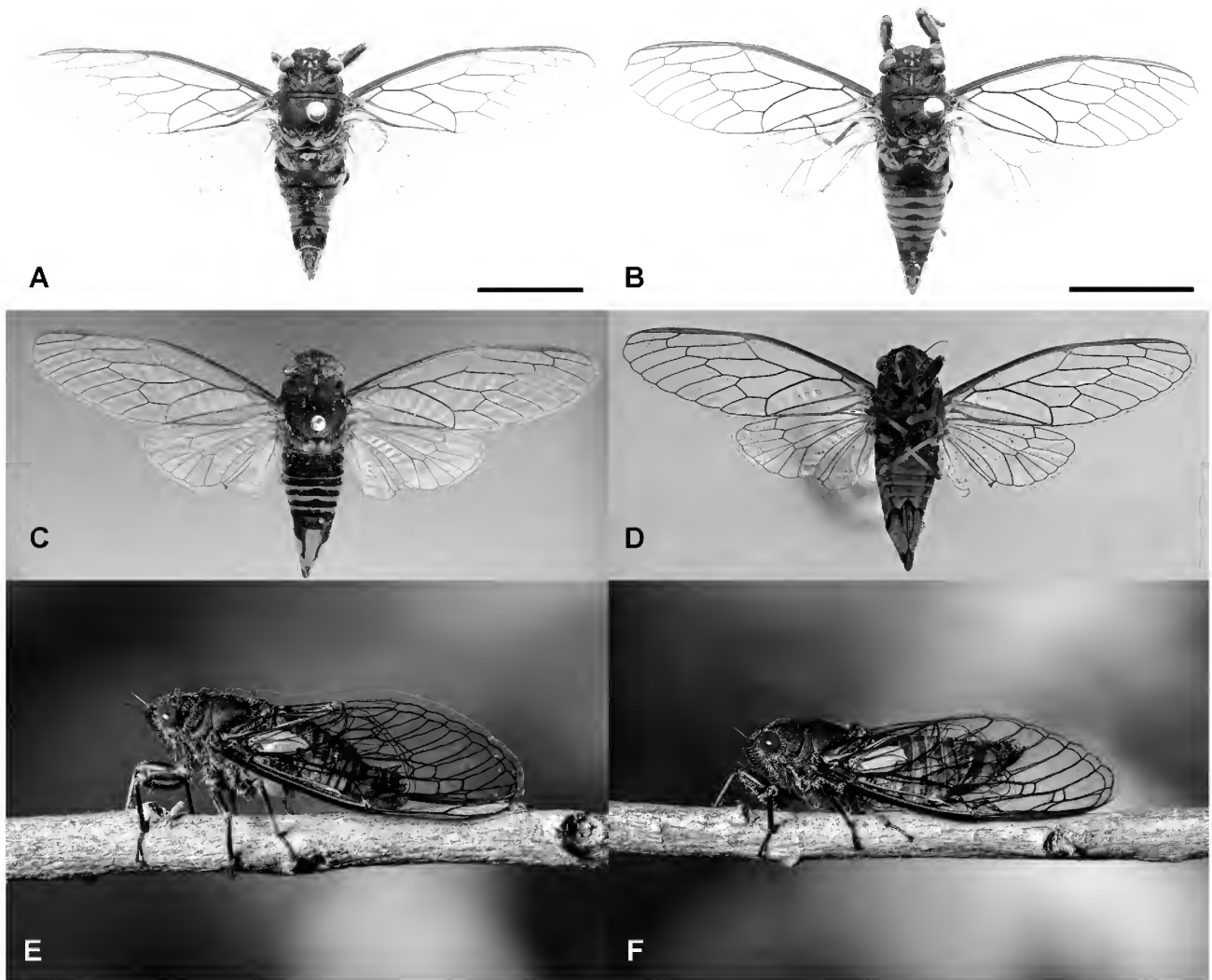
*Opercula* (Fig. 3K) broad, rounded on inner edge, following body axis ventrolaterally, depressed centrally; cream-white throughout; clearly separated.

*Timbals* (Fig. 2J) with five distinct long ribs; long ribs 1–3 extending across membrane and fused dorsally along basal spur; long ribs 4 and 5 abbreviated; long rib 4 with an isolated ventral extension; long rib 5 independent of basal spur, comparatively shorter, extending ventrally across half of membrane; large ridged dome on posterior timbal plate extending across two-thirds of timbal; apodeme pit oval-shaped.

*Abdomen.* Tergite 1 black, with reddish-brown margins over timbal cavity; tergite 2 black, sometimes with dark reddish-brown areas ventrolaterally; tergite 3 mainly black, with diffuse, orange-brown areas laterally; tergites 2 and 3 with conspicuous silver pubescence; tergites 4–7 grading from orange anteriorly, through yellow-brown to dark brown posteriorly, with dark brown colouration in medial areas extending into wedge-shaped patterns with apices directed anteriorly; intersegmental membranes bright orange; tergite 8 mainly dark reddish-brown to black with broad orange areas dorsolaterally and laterally on the anterior margin. Epipleurites 3–6 orange-brown. Sternite I black; sternite II black with yellow-brown areas laterally; sternites III–VI orange; sternite VII orange with black spot on posterior midline; sternite VIII brown, darker at base, with yellowish pubescence.

*Genitalia* (Fig. 39). Pygofer mainly black; dorsal beak black, brown at tip, anal styles pale orange-brown; upper lobes mainly orange-brown; basal lobes brown. Uncus brown, blunt and insignificant; upper lobes in ventral view bulbous, with rounded lateral termination; basal lobes in





**Figure 38.** *Yoyetta aaede* (Walker) (A) male, Mt Lofty (34°59'S 138°43'E), dorsal habitus; (B) male, Mt Lofty, ventral habitus; (C), holotype female, Adelaide, dorsal habitus; (D), holotype female, ventral habitus (holotype photos by Ken Merrifield); (E), male, live specimen Adelaide (34°56'S 138°39'E), photo by NJE; (F), female, live specimen, Adelaide, photo by NJE). Scale bars = 10 mm.

lateral and ventral views broadly rounded; claspers divided, juxtaposed, with apices broadly rounded. Aedeagus with pseudoparameres not extending half the length of theca; theca recurved ventrally at approximately 160° towards apex, with two broad spines on outer margin of recurvature, and small dorsal ornamentation along apical third; apex with two spines on lateral sides with apices pointing in direction thecal termination.

**Female** (Fig. 38C–D, 38F). *Head, thorax, legs and wings* matches description given for male.

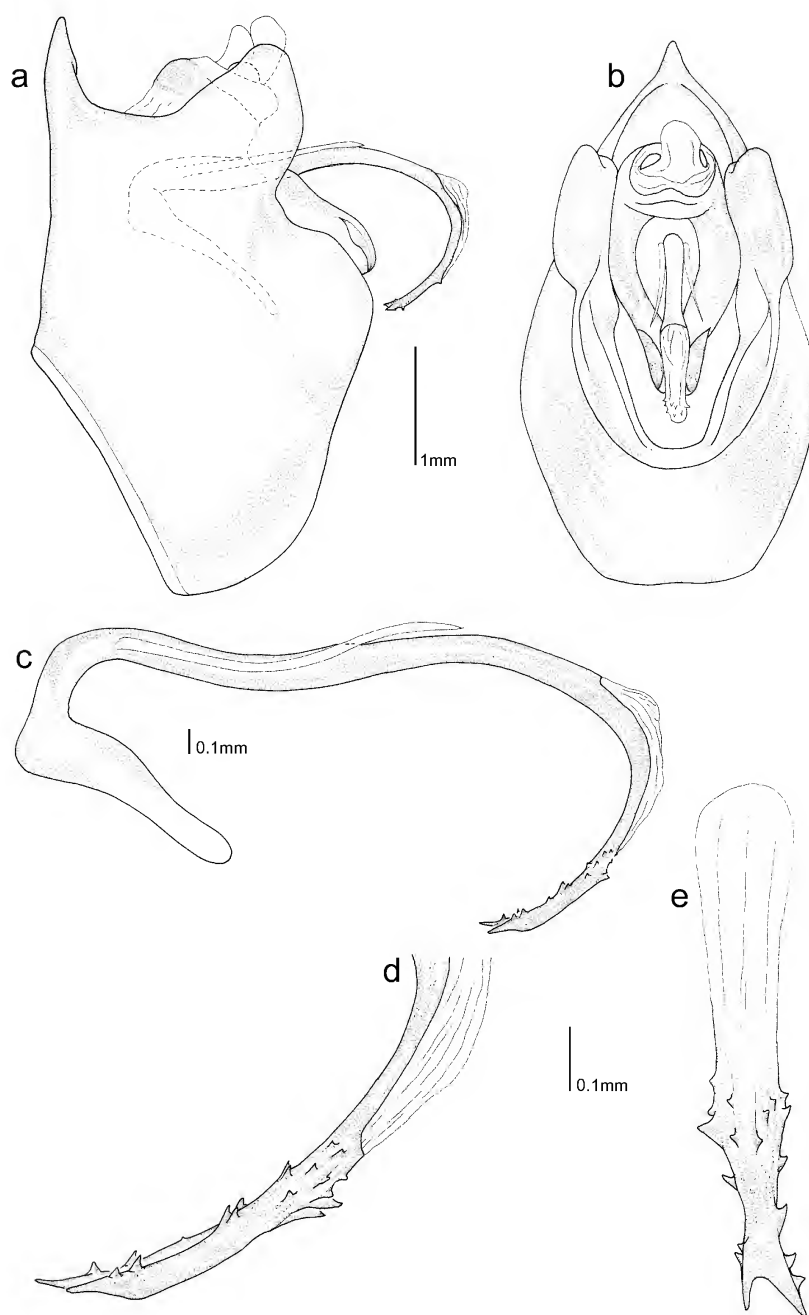
**Abdomen.** Tergites 1–3 black; tergites 3 and 4 mainly black, with small orange areas on anterior lateral sides; tergites 6–8 mainly black with prominent orange bands along anterior margin, broadening laterally; abdominal segment 9 pale brown with a longitudinal black stripe dorsolaterally on each side of midline, and extending ventrally broadly along

anterior margin. Dorsal beak black; ovipositor sheath barely extending beyond apex of abdominal segment 9. Anal styles orange-brown.

**Measurements** (in mm; range with mean in parentheses: 12 males, 12 females).

**Body length:** male 17.4–19.0 (18.1); female 18.1–20.3 (19.2). Fore wing length: male 19.2–21.1 (20.2); female 20.6–22.2 (21.5). Head width: male 4.8–5.6 (5.1); female 5.0–5.7 (5.2). Pronotum width: male 5.2–5.9 (5.4); female 5.4–5.7 (5.5). Abdomen width: male 5.2–6.2 (5.7); female 5.5–5.6 (5.6); ovipositor length 5.5–6.2 (5.9).

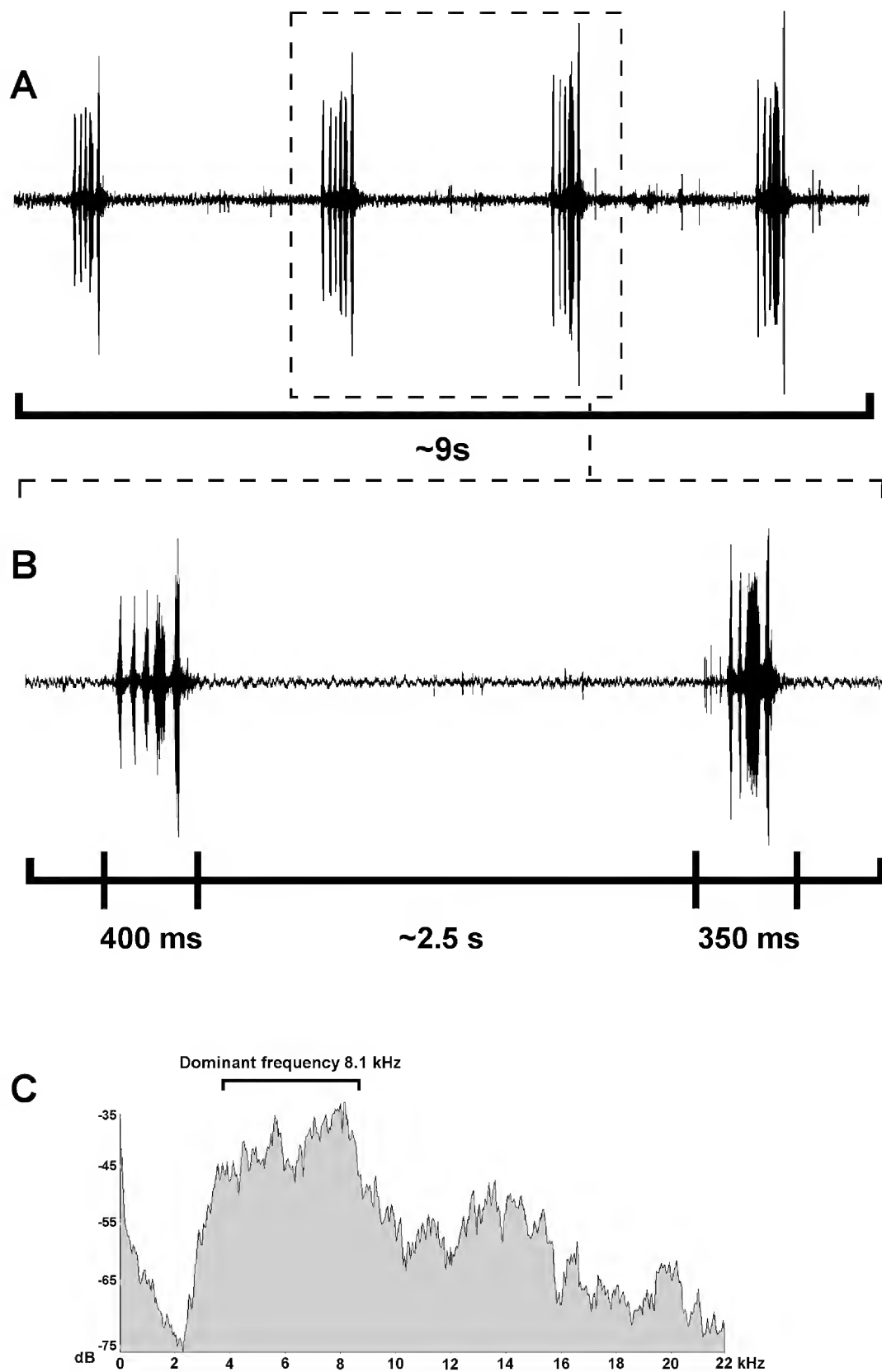
**Distinguishing features.** *Yoyetta aaede* is readily distinguished from all other species in the *Y. abdominalis* group by the presence of extensive orange colouration on the anterior lateral sides of tergites 4–7 (in all other relevant species, the



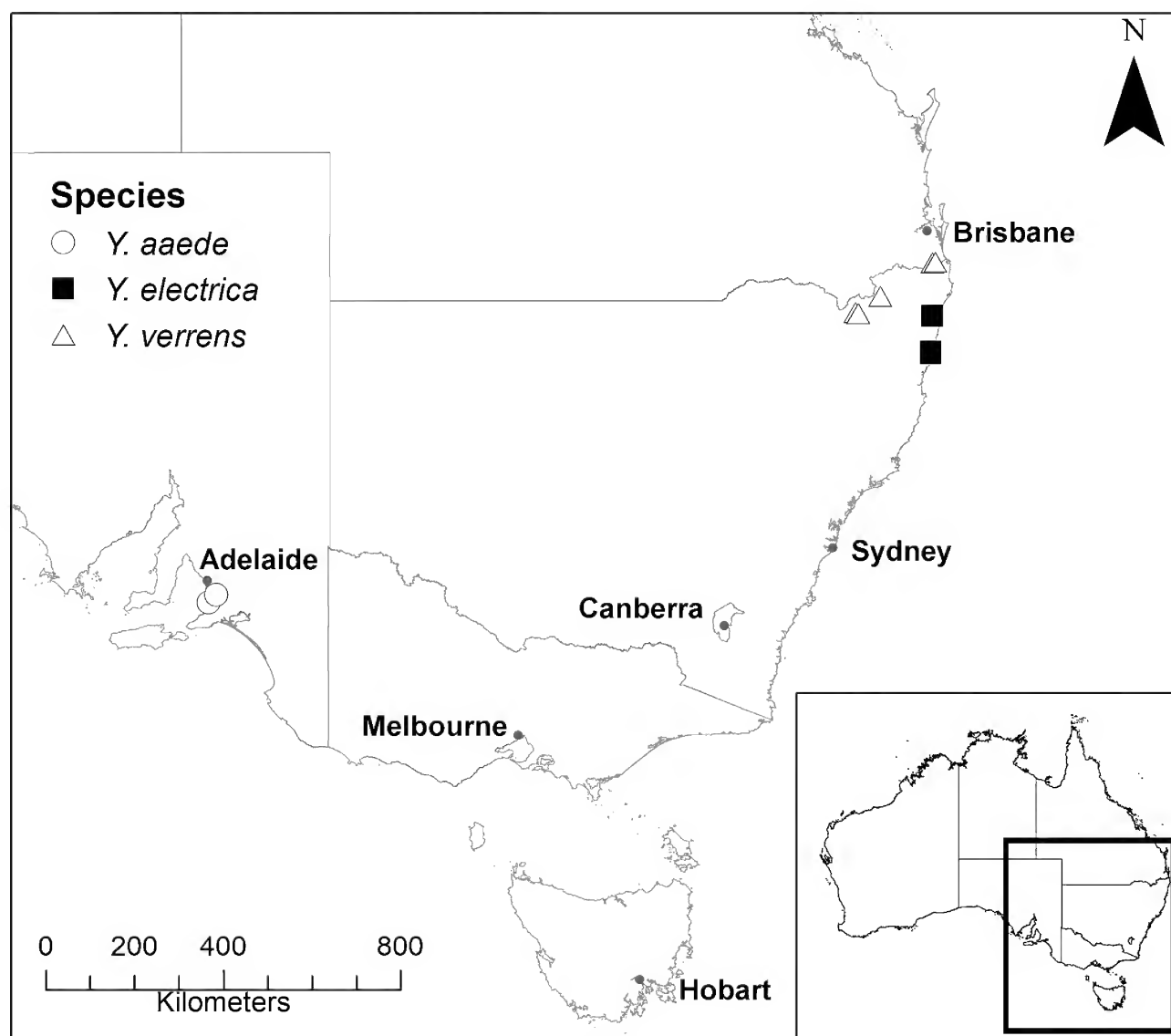
**Figure 39.** *Yoyetta aeede* (Walker), illustration of male pygofer and internal genitalia; (a) viewed laterally from the left; (b) viewed ventrally; (c) aedeagus; (d) apex of theca, viewed laterally from left; and (e) apex of theca, viewed ventrally. Characters as depicted in Fig. 4. Specimen from Mt Lofty (34°59'S 138°43'E).

anterior lateral sides of the tergites is predominantly black or dark brown. It can also be distinguished from *Y. denisoni*, *Y. kershawi* stat. rev., comb. nov., *Y. timothyi* sp. nov. and *Y. grandis* sp. nov. by its smaller size (body length <23 mm) and from all species apart from *Y. hunterorum*, *Y. grandis* sp. nov. and *Y. serrata* sp. nov. by having white basal membranes in the fore wings. It differs further from *Y. hunterorum* by the extensive orange (c.f. dull yellow) colouration of the sternites. Its appearance is similar to *Y. serrata* sp. nov., although it lacks the orange triangular on the lateral tergites are distinctive in that species. In addition, the males of *Y. aeede* have opercula that are entirely white or pale grey (cf. black at base in *Y. serrata* sp. nov.).

**Calling song** (Figs 40, 53H). The calling song of *Y. aeede* sp. nov. was recorded from a single male in captivity (Fig. 40). The call structure of this species consists of simple repetitive phrases, each comprising a series of either four or five macrosyllables. As illustrated in Fig. 40B, sometimes the fourth and fifth macrosyllable coalesce into a single longer macrosyllable. Macrosyllables generally range between 32 and 51 ms duration ( $n = 1$ ). By comparison, the longer (coalesced) macrosyllable ranges between 88 and 139 ms duration. The phrase repetition rate for the call ranges from c. 2.4–3.0 s. The highest amplitude frequency plateau from the captive recording broadly ranged between 3.4 and 9.3 kHz with a dominant frequency around 8.1 kHz (Fig. 40).



**Figure 40.** Male calling song structure of *Yoyetta aeede* (Walker), illustrated in waveform plots, including (A) four phrases, (B) an expanded section (from A) illustrating two phrases. The final subfigure (C) is a spectrogram displaying song frequency. The specimen from Adelaide (34°56'S 138°39'E) was recorded from a single male in captivity by NJE using RS6.



**Figure 41.** Map of southeastern Australia showing the geographical distribution of *Yoyetta aaede* (Walker) (open circles), *Y. verrens* sp. nov. (open triangles) and *Y. electrica* sp. nov. (closed squares).

### *Yoyetta verrens* sp. nov.

<http://zoobank.org/NomenclaturalActs/025D81F6-5094-41D4-B0F9-35BCADE515DC>

Figs 2F, 3F, 41–47, 53F

**Holotype** ♂, Blatherarm Camp, Torrington, 29.2523°S 151.7072°E, 4–7.i.2016, L. Popple, at light, 515-0001 (AM K.549270). **Paratypes** NEW SOUTH WALES: 1♀, same data as holotype, 515-0005 (AM K.549271); 1♂, same data as holotype, 515-0003 (DE); 2♂♂, same data as holotype, 515-0002 [genitalia prep.], 515-0004; 1♂, Butler Mine track, Torrington, 29.2367°S 151.6466°E, 5.i.2016, L. W. Popple, 515-0006, SL100704 (LWP).

**Additional locations with audio recordings.** QUEENSLAND: Daves Creek, Lamington National Park, 28°13'21"S 153°12'35"E, 12.xii.2017; Canyon Parade, Springbrook National Park, 28°13'12"S 153°16'22"E. NEW SOUTH WALES: L. W. Popple; Basket Swamp National Park, NSW, 28°54'34"S 152°09'12"E, 21.xi.2001, L. W. Popple.

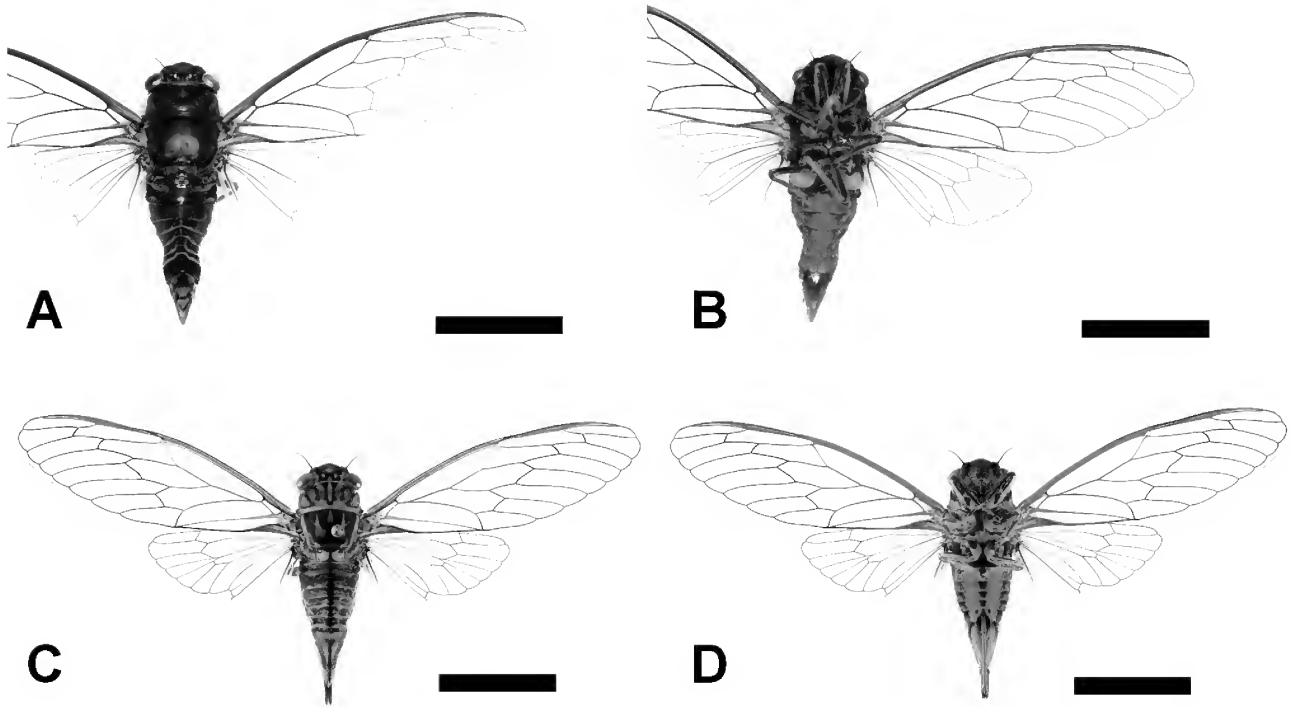
**Distribution, habitat and seasonality.** Restricted to moderately high altitude areas (above c. 600 m) the Queensland/New South Wales border region from the Macpherson Range southwest to Torrington State Conservation Area (Fig. 38). Adults are active in the middle to upper canopy of eucalypt

forest and are rarely observed at close quarters. They are present from November to January.

### Description

**Male** (Figs 2F, 3F, 42A–B, 43–47). **Head** almost as wide as mesonotum, black, with a central dark brown fascia posterior to ocelli; ocelli pink; dorsal side of postclypeus black anteriorly, brown over remainder; ventral side of postclypeus black with black transverse grooves, lateral and posterior borders brown; anteclypeus black, rostrum black at base, dark brown centrally, black at apex, reaching anterior edge of hind coxae; lora black; gena black; eyes dull black; antennae black, supra-antennal plates black, brown at base of pedicel.

**Thorax** mainly black with variable brown patterning. Pronotum black, a thin central brown line on anterior half, dark brown on lateral angles; fissures mainly black; pronotal collar black. Mesonotum black, posterior margin dark brown centrally, becoming black laterally, cruciform elevation arms black, lateral depressions brown. Metanotum black.



**Figure 42.** *Yoyetta verrens* sp. nov., (A) male, Torrington (29°15'S 151°42'E), dorsal habitus; (B) male, Torrington, ventral habitus; (C) female, Torrington, dorsal habitus; (D), female, Torrington, ventral habitus. Scale bar = 10 mm.

**Legs.** Coxae mainly black; coxal membranes red; basisterna black, katapisterna brown posteriorly; meracantha small, narrow, cream, black at base, pointed, minimally overlapping opercula; fore femora orange anteriorly, black medially, brown strip laterally, black posteriorly and around base of femoral spines; femoral spines erect, brown at base, becoming black at tips; mid and hind femora black, orange-brown medially, distal femoral joint orange; fore- and mid-tibiae black laterally, orange-brown over remainder; hind-tibiae orange brown; tarsi orange-brown becoming black towards claws; claws dark brown, black at tips.

**Wings** with fore wing costal veins dark brown, darker central rib; pterostigma dark brown; basal cell translucent with black anterior border; basal membranes bright orange; other veins dark brown to black, with eight apical cells; hind wing plagas dull white along margins of anal cell 3 and vein 2A, central area of jugum clear, clear posteriorly, with six apical cells.

**Opercula** (Fig. 3F) medium, spatulate, following body axis ventrolaterally, depressed centrally, black over basal half, stippled brown-cream across central areas, posterior margins orange yellow, clearly separated.

**Timbals** (Fig. 2F) with five distinct long ribs; long ribs 1–4 extending across surrounding membrane and fused dorsally along basal spur; long rib 5 independent of basal spur, comparatively shorter, extending ventrally across half of membrane; prominent intercalary rib between long ribs 3 and 4; large ridged dome on posterior timbal plate extending across two-thirds of timbal; apodeme pit oval-shaped and conspicuous.

**Abdomen** with tergite 1–2 black; tergites 3–7 black with orange posterior margins, extending anteriorly to cover lateral margins; tergite 8 shiny black, lateral face dark brown posteriorly, lateral margins orange. Epipleurites with medial anterior strip, orange over remainder. Sternite II mainly black;

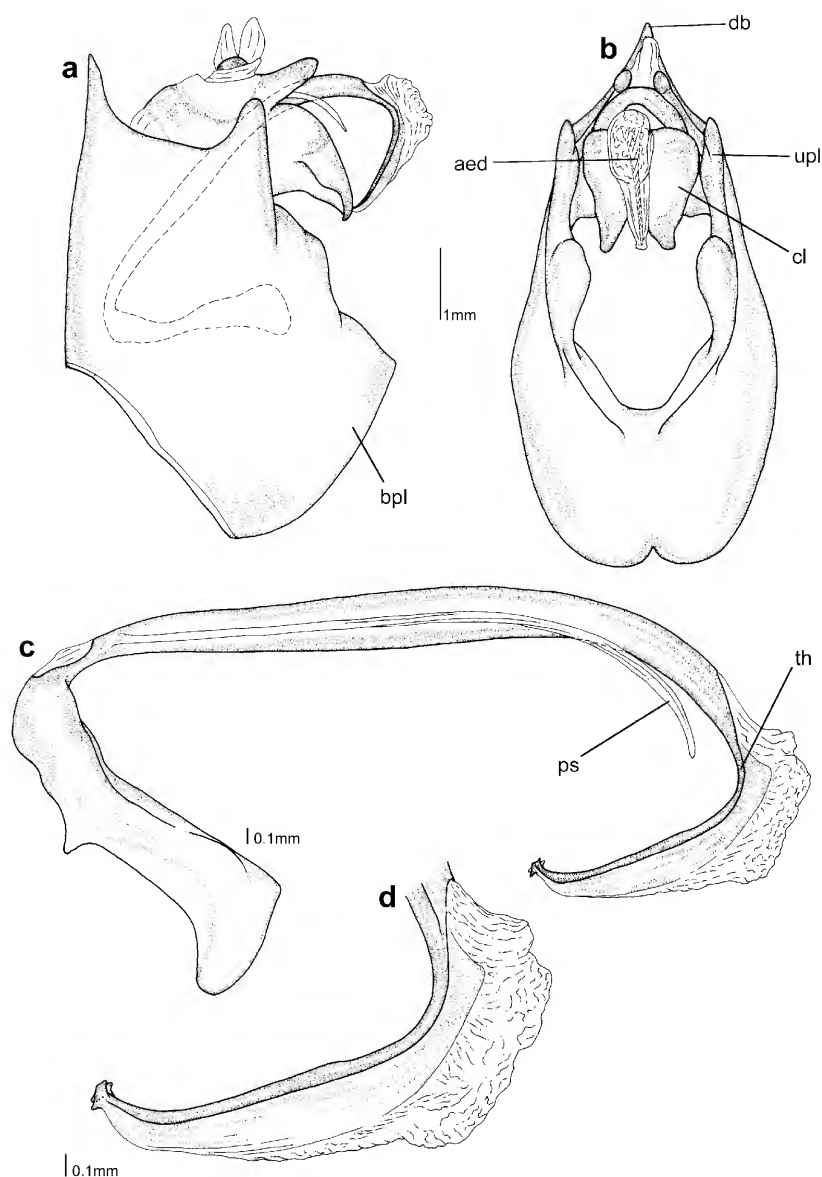
sternite III black, orange posterior margin; sternites IV–VII orange; sternite VIII dark brown anteriorly, becoming dark orange posteriorly, with brownish pubescence.

**Genitalia** (Fig. 43). Pygofer black; dorsal beak with ochraceous tip, anal styles orange; upper lobe black, ochraceous and rounded posteriorly; basal lobe black. Uncus dark brown; lateral process beak-like, hooked ventrally; lobes in ventral view bulbous, with tapering lateral termination; claspers black, apposed at base, clearly divided anteriorly, short, with apices rounded, gradually tapering laterally. Aedeagus with pseudoparameres extending around two-thirds the length of theca; theca recurved ventrally at 120° towards apex, with spectacular transparent flange along the outer margin of recurvature, this broadly smooth along theca with prominent lateral ornamentations, together >5 times width of theca, terminating at apex; apex short, knob-like, with 4–6 distinct cornuti around base.

**Female** (Fig. 42C–D). Similar to male, but with overall lighter colouration.

**Head** mainly brown with black markings surrounding ocelli and extending to supra-antennal plate; a black spot on anterior side of each compound eye; postclypeus ochraceous on dorsal side, black on ventral side with central ochraceous spot anteriorly, also ochraceous on extreme margins; anteclypeus and rostrum black; gena black; mandibular plates mainly ochraceous, black posteriorly.

**Thorax.** Pronotum mainly brown with an ochraceous midline; black markings along fissures and surrounding midline; pronotal collar brown, with extreme edges of lateral angles dark brown; mesonotum brown with black submedian and lateral sigilla, and a diffuse black central marking extending anteriorly from cruciform elevation; cruciform elevation black on central, medial portion and lateral margins, yellow-ochraceous on posterior margins and



**Figure 43.** *Yoyetta verrens* sp. nov., illustration of male pygofer and internal genitalia; (a) viewed laterally from the left; (b) viewed ventrally; (c) aedeagus; and (d) apex of theca. Characters as depicted in Fig. 4. Specimen from Torrington (25°15'S 151°44'E).

lateral depressions; scutal depressions black; wing grooves ochraceous with central black spot; metanotum lurid brown.

*Wings* match description given for male, with venation mainly a paler brown.

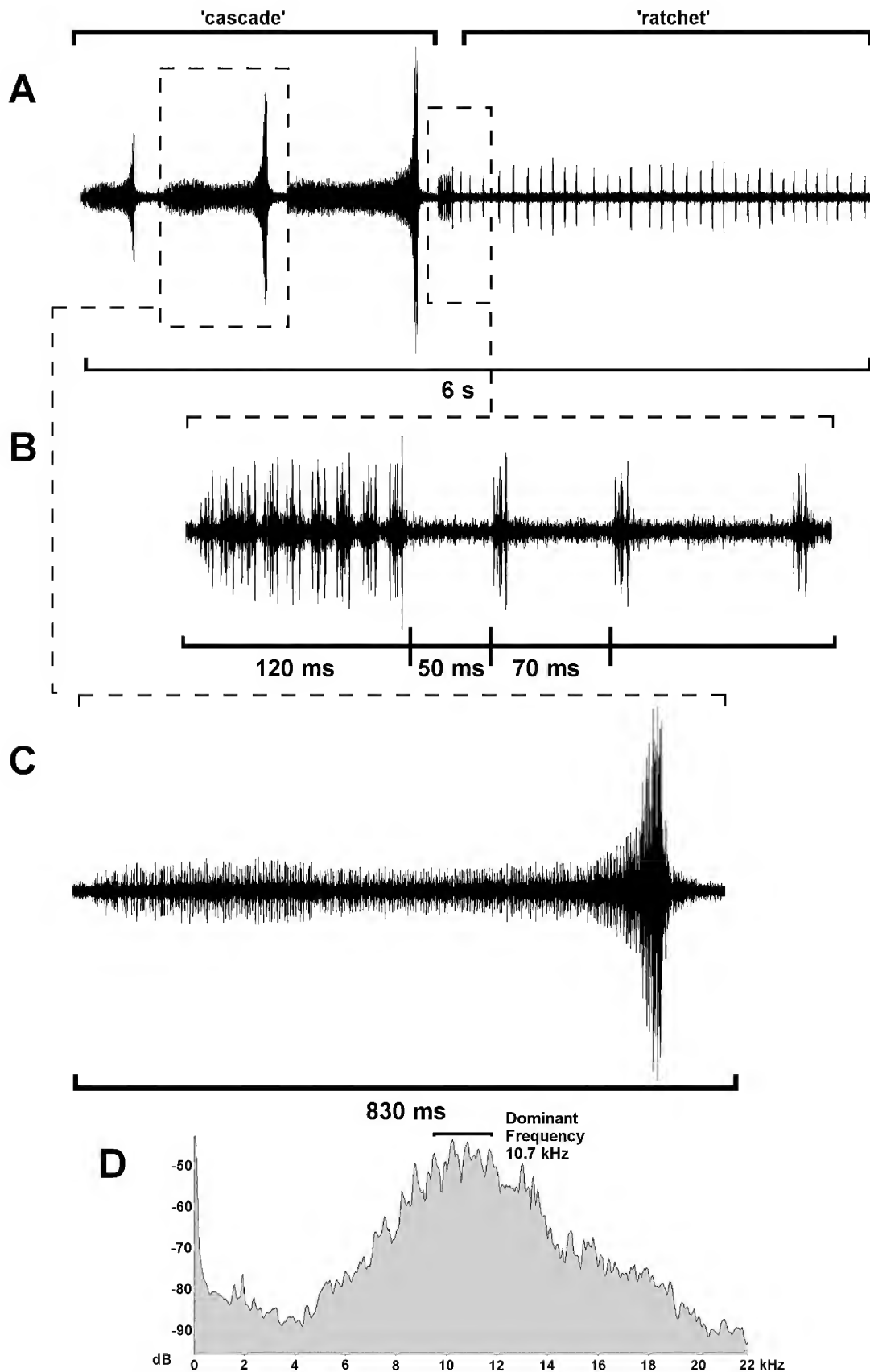
*Legs.* Coxae mainly brown; coxal membranes orange; basisterna dark brown to black, katapisterna mainly brown; meracantha as in male; fore femora black anteriorly with an orange stripe, mainly brown posteriorly and around base of femoral spines; femoral spines erect, brown at base, becoming black at tips; mid and hind femora dark brown to black anteriorly, brown posteriorly; distal femoral joint orange; fore- and mid-tibiae dark brown to black anteriorly, orange-brown over remainder; hind-tibiae pale orange-brown; tarsi orange-brown becoming black towards claws; claws dark brown, black at tips.

*Abdomen.* Tergite 1 black, tergite 2 mainly black with reddish-brown posterior margins on dorsolateral sides; tergites 3–7

black with reddish-brown posterior margins, grading to orange-brown and broadening ventrally; tergite 8 mainly orange-brown, black along anterior margin; epipleurites mainly orange-brown, with diffuse black interiorly; sternite II black with orange black posterior margins ventrolaterally; sternites III–VI orange-brown with narrow black midline; sternite VII orange-brown with anterior black spots on either side of midline; abdominal segment 9 orange-brown with three longitudinal black stripes, one on midline and two broader examples either side of midline; dorsal beak black; ovipositor sheath extending approximately 2 mm beyond apex of abdominal segment 9; anal styles orange.

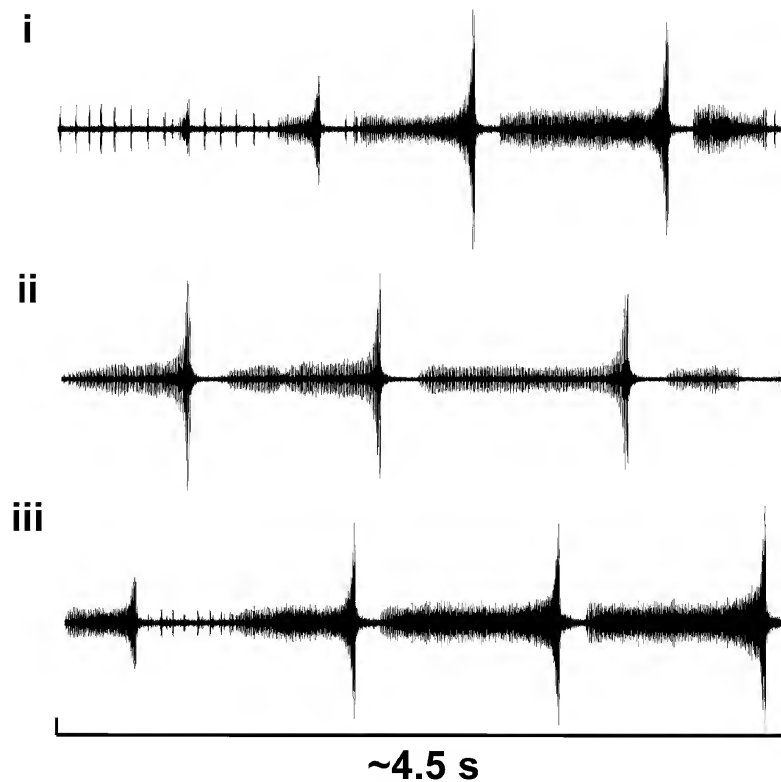
**Measurements** (in mm; range with mean in parentheses: 5 males, 1 female).

**Body length:** male 22.1–24.7 (23.3); female 26.1. Fore wing length: male 27.8–29.6 (28.6); female 31.8. Head width: male

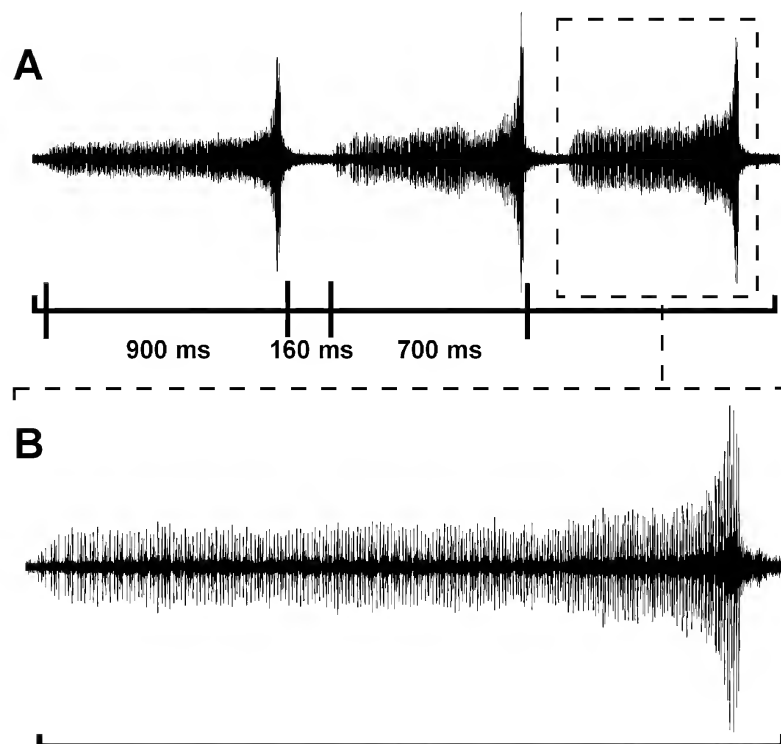


**Figure 44.** Typical male calling song structure of *Yoyetta verrens* sp. nov., illustrated in waveform plots and a spectrogram from recordings in the field at Torrington (29°15'S 151°42'E) by LWP using RS3 (see Methods and Terminology). This includes (A) a broad plot commencing with the “cascade” mode and progressing into the “ratchet” mode; (B) a segment (from A above) showing the beginning of the ratchet mode; (C) another expanded segment (from A) illustrating the structure and marked amplitude modulation of a single echeme from the cascade mode; (D) a spectrogram displaying song frequency.

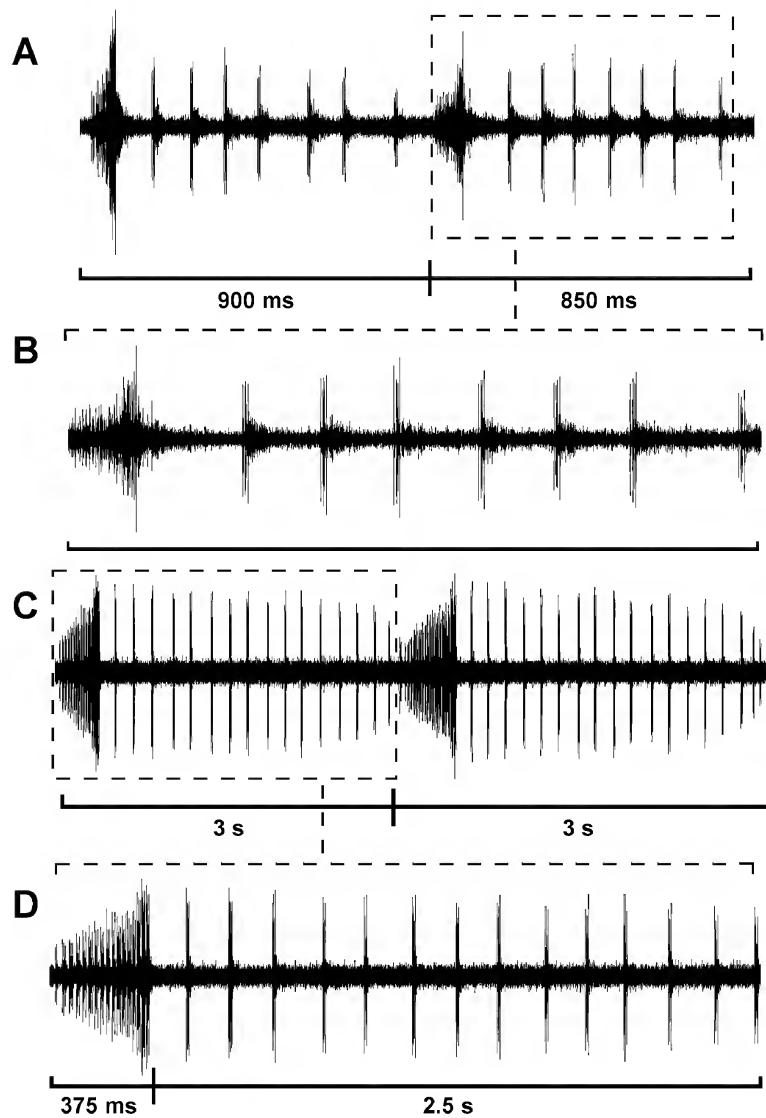




**Figure 45.** Comparisons of the “cascade” mode of the calling song of *Yoyetta verrens* sp. nov., illustrated in wave plots from three localities, including (i) Torrington, (29°15'S 151°42'E); (ii) Blatheram (29°15'S 151°42'E); (iii) Basket Swamp (28°55'S 152°09'E). Each was recorded by LWP using RS3 (see *Methods and terminology*).



**Figure 46.** Wave plots illustrating the “cascade” mode of the calling song of *Yoyetta verrens* sp. nov., produced in flight. The illustration (A) includes a simple series of 3 echemes, each ending with an acute amplitude modulation, giving the song a sweeping quality. The lower plot (B) is expanded from the one above to illustrate the detailed structure of a single echeme. Recorded in the field at Torrington (29°15'S 151°42'E; 515-184 Torrington2) by LWP using RS3 (see *Methods and Terminology*).



**Figure 47.** Examples from the “ratchet” mode from the calling song of *Yoyetta verrens* sp. nov. These include (A) two phrases from Torrington (25°15'S 151°44'E); (B) one phrase expanded (from A above); (C) two phrases from Blatherarm (29°15'S 151°42'E); (D) one phrase expanded (from C above). Recordings were made in the field by LWP using RS3 (see *Methods and terminology*).

6.4–6.6 (6.5); female 7.1. Pronotum width: male 6.4–7.0 (6.6); female 7.2. Abdomen width: male 5.7–7.1 (6.5); female 6.4; ovipositor length (female): 9.7.

**Etymology.** The Latin name “*verrens*” means “sweeping”, which represents the nature of the calling song of this species in flight.

**Distinguishing features.** Males of *Y. verrens* sp. nov. have contrasting orange bands on the posterior margins of tergites 3–7, a feature that readily distinguishes them from *Y. denisoni*, *Y. kershawi* stat. rev., comb. nov. and *Y. timothyi* sp. nov. They can be readily distinguished from *Y. abdominalis*, *Y. aaede*, *Y. spectabilis* sp. nov., *Y. electrica* sp. nov. and *Y. serrata* sp. nov. by (1) their larger size with body length >22 mm, and (2) lack of symmetrical, orange triangular patterns on dorsolateral sides of tergites 4–7. Males of *Y. verrens* sp. nov. differ from those of *Y. grandis* sp. nov. and *Y. subalpina* by the colour of the hind wing plaga, which is dull white and restricted along the margins of anal cell 3

and vein 2A in *Y. verrens* sp. nov., whereas in *Y. grandis* sp. nov. and *Y. subalpina* this colouration is brighter and extends over the entire jugum. In addition, the orange-red coloration on the opercula of *Y. verrens* sp. nov. contrasts with the grey coloration on *Y. grandis* sp. nov. and the bright orange colour of the fore wing basal membranes on *Y. verrens* sp. nov. are dull orange to grey in *Y. grandis* sp. nov. Females can be distinguished from all of the aforementioned species by their characteristically long ovipositor sheath, which extends >2 mm beyond the apex of abdominal segment 9.

**Calling song** (Figs 44–47, 53F). Males of *Yoyetta verrens* sp. nov. call whilst stationary and also in flight. When stationary there are two different modes of song production, one which we term the “ratchet” mode (Figs 44, 47) and another which is described as the “cascade mode” (Fig. 44–46). In flight, a simple series of echemes is produced, each ending with an acute amplitude modulation as illustrated in Fig. 46, which gives the song a “sweeping” quality.

Several recordings have been obtained from the type locality

and nearby vicinity in Torrington State Conservation area (Figs 44–47). Based upon these recordings ( $n=11$ ), the ratchet mode comprises monotonously repeated phrases, composed of a syllable sequence (7–55 single syllables, doublets, or rarely triplets, each 0.01–0.03 s duration, separated by gaps of 0.073–0.142 s) and an echeme (0.1–0.428 s duration), followed by a gap (0.09–0.18 s duration) (Figs 44, 47). The echemes at the end of each phrase show an acute amplitude modulation, which is most obvious in longer duration examples ( $>0.3$  s). These longer examples are often produced in the transition from the ratchet mode to the cascade mode.

The cascade mode commences with a series of three or four long echemes, increasing successively in duration (each 0.47 s to 1.94 s duration), and each separated by gaps of 0.146–0.302 s. In a similar structure to the call produced in flight, each of the long echemes ends with an acute amplitude modulation, although in this case there are differences in the duration of the different echemes, with the last two echemes being longer than the preceding one(s). This is then often followed by a soft, short echeme (0.12–0.18 s duration), then a gap of 0.05–0.34 s. A syllable sequence (as described for the ratchet mode, but often longer and with gaps between echemes being 0.1–0.3 s duration) then completes the phrase. A breakdown of this song mode is provided in Figs 45, 46.

Few recordings of this species have been obtained outside of the type locality. A single recording of the cascade mode from Basket Swamp (approximately 55 km north-east of the type locality) were found to fall broadly within the range of calling song variation present at the type locality in terms of temporal structure (Fig. 46). The only localities from which recordings have been taken is at Daves Creek in Lamington National Park and nearby at Canyon Parade, Springbrook National Park. These recordings (two of a male in flight and another of the cascade song mode) were found to be broadly similar in temporal structure to the type locality; however they are too faint for the purposes of illustration.

There were found to be no apparent modulations in song frequency between the two modes of the calling song. In the vicinity of the type locality, the male calling song has a highest amplitude frequency plateau that typically falls approximately between 8.5 and 13.0 kHz, with dominant frequencies of 10.7–11.1 kHz (Fig. 44). Recordings from north-east of the type locality were found to have a higher overall frequency. To the north, at Basket Swamp, the dominant frequency of the only available recording is 11.7 kHz, which is only slightly higher. Further afield at Daves Creek, the frequencies ranged even higher (plateau of 9.4–14 kHz, with dominant frequency between 11 and 12.4 kHz).

No recordings of male-female duets have been obtained for this species. However, observation in the field based on successful simulation of female wing-flick responses suggest that the females respond during the gaps that follow each long echeme that ends with an acute amplitude modulation. These echemes are produced: (1) as the ratchet mode transitions toward the cascade mode, (2) during the cascade mode itself, and (3) in flight. The males appeared to be responsive to simulated wing-flicks during each of these calling song modes/situations.

The calling song of *Yoyetta verrens* sp. nov. is unlike others in the *Y. abdominalis* species group. It shares some features in common with *Y. subalpina* sp. nov.; however, it can be distinguished easily by its more simplistic sweeping echemes (cf. two-note phrases in *Y. subalpina* sp. nov.).

## *Yoyetta electrica* sp. nov.

<http://zoobank.org/NomenclaturalActs/D441F85C-B655-4261-998E-0E4A4D5253FD>

Figs 2K, 3I, 4I, 48–50, 53C

**Holotype** ♂, Arrawarra, New South Wales North Coast, 7.xii.1962, C. W. Frazier, at light, Uni. Of New England Coll., donated 1983, ANIC database no. 20 005385, BOLD proc. ID: ANICY740-11 (ANIC). **Paratypes** NEW SOUTH WALES: 1♂ same data as holotype, ANIC Database No. 20 005386, BOLD Proc. ID ANICY741-11 (ANIC); 1♀, Lorikeet Tourist Park, Arrawarra, 30°2'32"S 153°11'22"E, 7.xii.2015, at light, L. Popple & A. McKinnon, 694-0003 (QM); 1♂ same data, 694-0001 (genitalia prep) (DE), 1♂ 1♀, same data 694-0002, 694-0004 (LWP).

**Additional locations with song recordings.** NEW SOUTH WALES: Tabbymobil Creek, Mororo, NSW, 29°18'09"S 153°12'49"E, 17.x.2013, L. W. Popple.

**Distribution, habitat and seasonality.** Known from coastal northern New South Wales within a small area south of Lismore and north of Woolgoolga (Fig. 41). Adults are active in the middle to upper canopy of eucalypt forest. They are present from November to January.

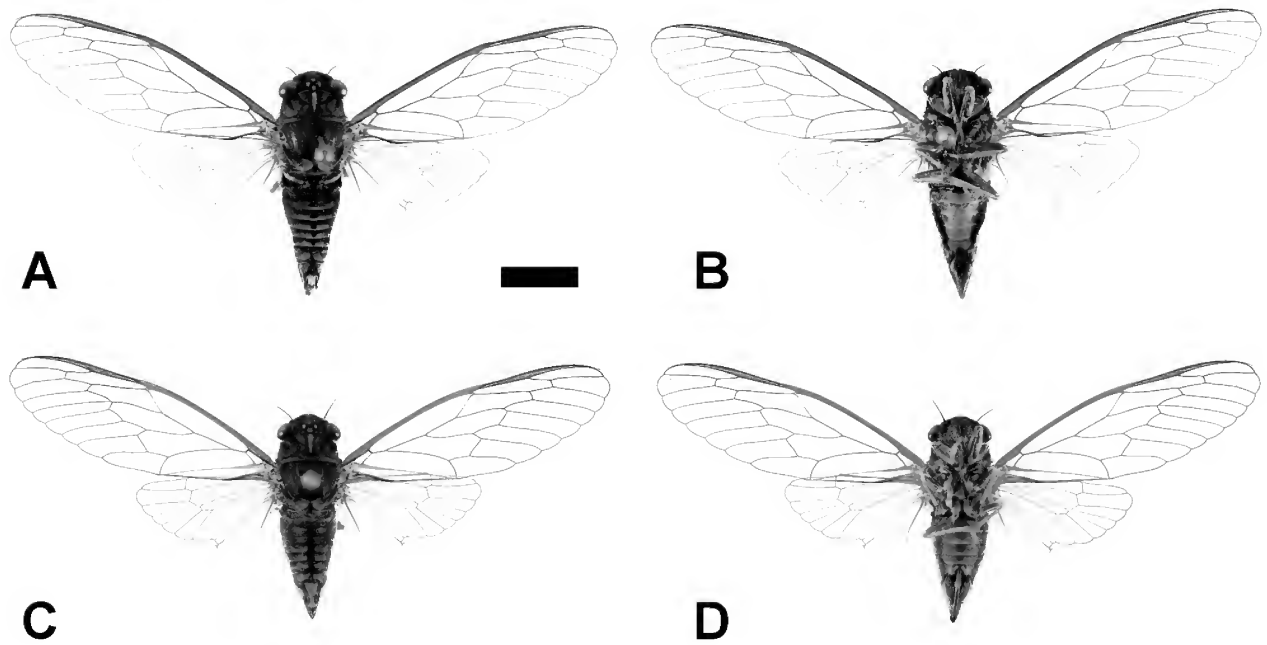
## Description

**Male** (Figs 2K, 3I, 48A,B). *Head* approximately as wide as to slightly wider than mesonotum; dorsally mainly black, with a small, tear-shaped, brown marking posterior to ocelli, reducing anteriorly; ocelli pink; dorsal postclypeus dark brown to black with ochraceous triangular median marking, apex directed anteriorly; ventral postclypeus black, ochraceous laterally with black transverse grooves; frons black; anteclypeus black; rostrum brown at base, black posteriorly, apex reaching middle of hind coxae; lora dull black; eyes ochraceous; antennae black, supra-antennal plates black, with brown spot on anterior margin above pedicel.

*Thorax* predominantly black. Pronotum black with ochraceous stripe on anterior half of midline, ridges between lateral and paramedian fissures variably black-brown, lateral margins brown; pronotal collar brown, anterior margin black. Mesonotum mainly black, browner between submedian and lateral sigilla; cruciform elevation with anterior arms brown, posterior arms black, lateral depressions pale yellow; metanotum black at midline, adjacent area brown, becoming black laterally.

*Legs.* Coxae mainly brown, black anteriorly; coxal membranes orange-red; meracantha small, narrow, white, black at base, pointed, minimally overlapping opercula; trochanters brown, black ventrally; fore femora black medially, ochraceous laterally with black and red longitudinal stripe, ochraceous at joints; femoral spines erect, brown at base, black at tips; mid and hind femora black medially, brown laterally; fore tibiae dark brown, black centrally, with spines variably dull ochraceous and black at tips; mid and hind tibiae pale brown; fore and mid tarsi dark brown, black at claws; hind tarsi ochraceous; claws brown, black at tips.

*Wings* with fore wing costal veins yellow at base, tending orange-brown with dark brown margins; pterostigma mottled brown; basal cell transparent; basal membranes orange; vein CuP+1A yellow; other veins mainly brown to intermodal line, black posteriorly; with eight apical cells; hind wing plagas white over entire anal cell 3 and vein 3A except distal extremity, with thin coverage of length of vein 2A, with six apical cells.



**Figure 48.** *Yoyetta electrica* sp. nov., (A) male, Arrawarra (30°02'S 153° 11'E) dorsal habitus; (B) male, Arrawarra, ventral habitus; (C) female, Arrawarra, dorsal habitus; (D), female, Arrawarra, ventral habitus. Scale bar = 5 mm.

**Opercula** (Fig. 3I) small, spatulate, following body axis ventrolaterally, depressed centrally; black at base, contrastingly cream-white to pale red across remainder, with black mottling; clearly separated.

**Timbals** (Fig. 2K) with five distinct long ribs; long ribs 1–4 extending across surrounding membrane and fused dorsally along basal spur; long rib 4 narrowing over ventral third, long rib 5 independent of basal spur, comparatively shorter, extending ventrally across half of membrane; large ridged dome on posterior timbal plate extending across two-thirds of timbal; apodeme pit oval-shaped and conspicuous.

**Abdomen.** Tergite 1 black, with brown margins over timbal cavity; tergite 2 black; tergites 3–7 black anteriorly with posterior margins bright orange, extending over lateral margins to epipleurites, increasingly brown over middle third; tergite 8 black along midline and posterior margin, brown laterally with black spot. Epipleurites 3–6 orange with diffuse black shading, slightly expanding posteriorly. Sternites I and II black; sternites III–VI orange-yellow with grey mottling over lateral halves; sternite VII pale orange with black spot on posterior midline; sternite VIII black, dark brown at apex, with yellowish pubescence.

**Genitalia** (Fig. 49). Pygofer mainly black; dorsal beak black, brown at tip, anal styles pale brown; upper lobe mainly black, pale brown at tip; basal lobe black with ochraceous margins. Uncus brown; in lateral view beak-like and stumpy; lobes in ventral view bulbous, with rounded lateral termination; claspers clearly divided, cylindrical, with apices gradually curved and tapering laterally. Aedeagus with pseudoparameres not extending half the length of theca; theca recurved ventrally at 300° towards apex, with transparent flange along outer margin of recurvature, edges broadly smooth along proximal half, prominently serrated with dorsal ornamentation from distal half to termination adjacent to apex of the theca; broadening to > 2× width of

theca ventrally; apex short, sclerotized, transparent, spine-like, with 4–6 cornuti, directed ventrally.

**Female** (Fig. 48C,D). *Head, thorax, legs and wings* matches description given for male.

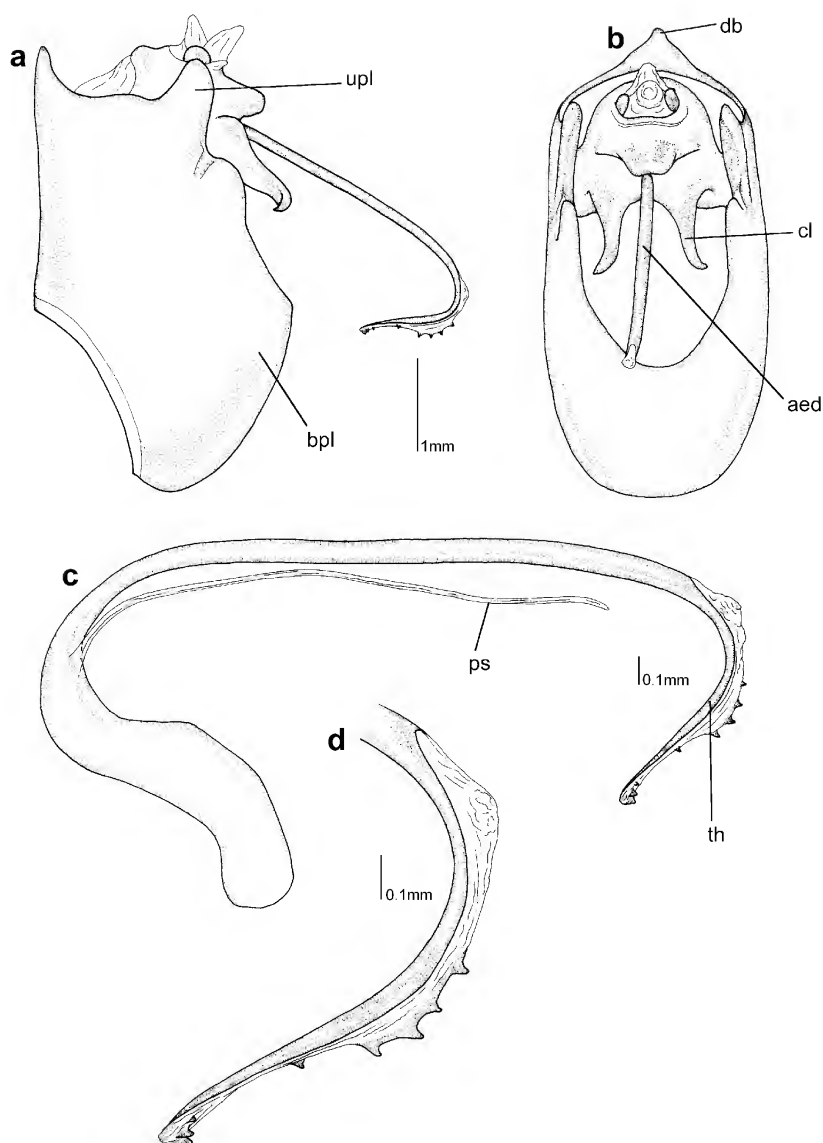
**Abdomen.** Tergite 1 black, tergite 2 mainly black with dark orange-brown posterior margins on dorsolateral sides; tergites 3–7 black with dark orange-brown posterior margins, increasing posteriorly; tergite 8 mainly orange-brown, black along anterior margin and medially; epipleurites mainly orange-brown, with diffuse black interiorly; sternite II black with orange black posterior margins ventrolaterally; sternites III–VI orange-brown with diffuse, dark brown to black midline; sternite VII orange-brown with small, diffuse, black spots at anterior edge on either side of midline; abdominal segment 9 pale brown with a longitudinal black stripe dorsolaterally on each side of midline, and extending ventrally on anterior margin. Dorsal beak black; ovipositor sheath barely extending beyond apex of abdominal segment 9. Anal styles pale brown.

**Measurements** (in mm; range with mean in parentheses: 4 males, 2 females).

**Body length:** male 15.8–17.4 (16.4), female 17.1–17.8 (17.4). Fore wing length: male 20.0–21.0 (20.5); female 23.5–24.3 (23.9). Head width: male 4.7–5.0 (4.8); female 5.2–5.5 (5.4). Pronotum width: male 4.4–4.8 (4.7); female 4.8–5.2 (5.0). Abdomen width: male 3.9–4.5 (4.2); female 4.4–5.2 (4.8).

**Etymology.** Refers to calling songs of this species, which, when multiple males are calling in the canopy, resembles the sounds created by high voltage power transmission lines.

**Distinguishing features.** *Yoyetta electrica* sp. nov. is readily distinguished from all of members of the *Y. abdominalis* species group, apart from *Y. aaede*, by its small size (BL < 18 mm). It can be distinguished from *Y. aaede* by



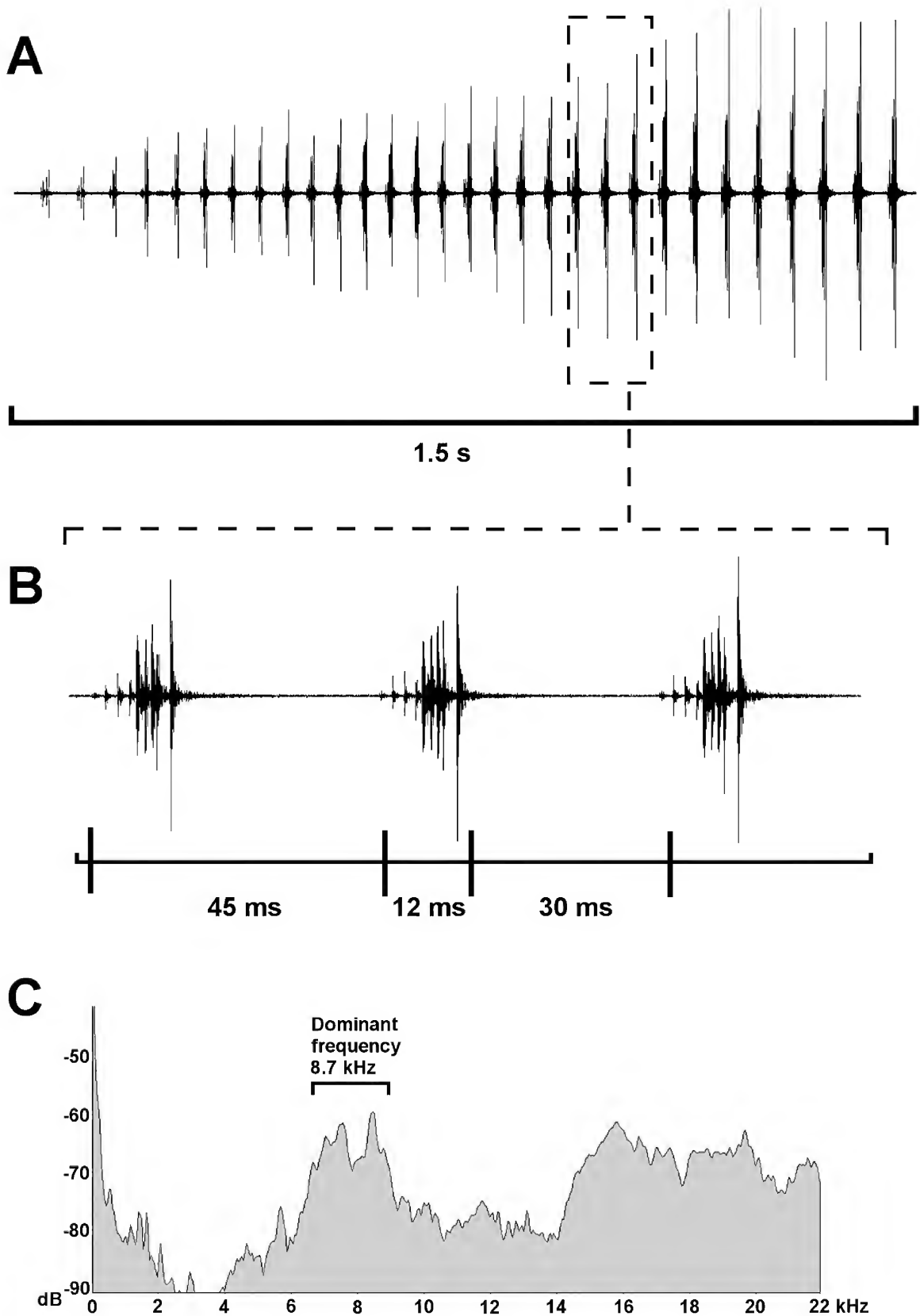
**Figure 49.** *Yoyetta electrica* sp. nov., illustration of male pygofer and internal genitalia; (a) viewed laterally from the left; (b) viewed ventrally; (c) aedeagus; and (d) apex of theca. Characters as depicted in Fig. 4. Specimen from Arrawarra (30°02'S 153°11'E). Scale bars = 5 mm.

the colouration of the anterior lateral tergites, which is predominantly dark brown to black (cf. orange).

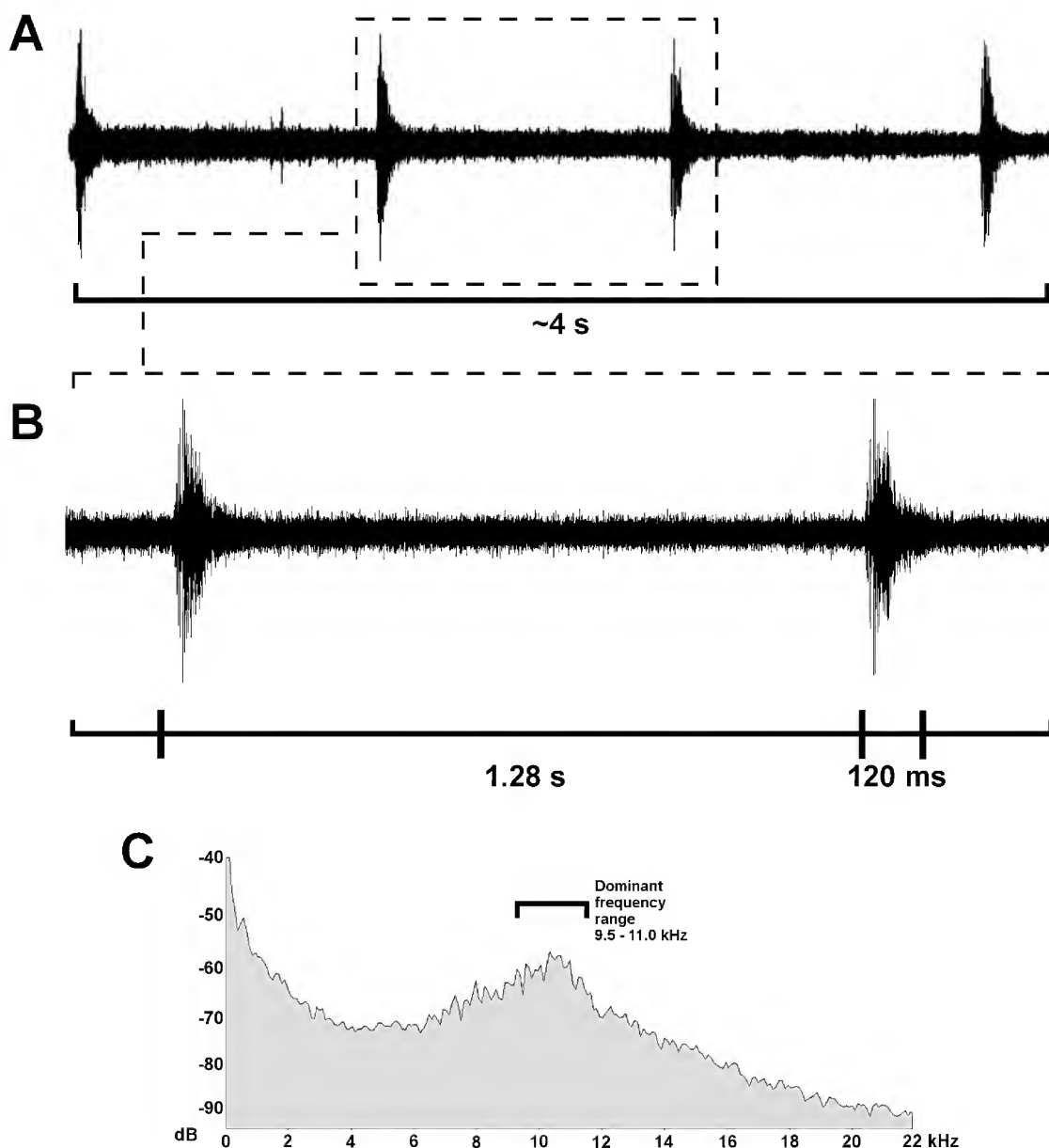
**Calling song** (Figs 50, 53C). Males of *Y. electrica* sp. nov. produce a bout of >25–100 syllables, each successively higher in amplitude and followed by a period of silence (Fig. 50;  $n = 8$ ). Each syllable is between 0.008 and 0.015 s duration, with a brief interval between syllables ranging from 0.03–0.04 s duration. The syllables form a “ratchet”-like component that ranges between 1.2 and 1.6 s duration in captivity and as long as 4.1 s duration in the field. The song is produced while males are stationary and the same song is also produced conspicuously in flight. It is unlike the call of any other species in the genus, although singing behaviour is reminiscent of *Y. denisoni*. The highest amplitude frequency plateau ranges from 6.5–9.0 kHz, with a dominant frequency around 8.5 kHz and a prominent harmonic plateau from >14.0 kHz.

### Additional locational records and song for *Yoyetta hunterorum*

In the original description, Moulds (1988) documented records of *Yoyetta hunterorum* from the New South Wales Central Coast and adjacent ranges south to Mount Kiera and Moss Vale. From the examination of additional specimens in existing collections, live specimens and analysis of song recordings, the distribution of *Y. hunterorum* is extended southwards along the Great Dividing Range through the southern highlands of New South Wales, the Snowy River National Park to the mountains east of Melbourne. As noted in Moulds (1988), the dorsal body coloration of specimens from the southern and mountain locations is predominantly black, while coastal specimens appear more variable, though generally lighter overall, ranging from black to brown-ochraceous.



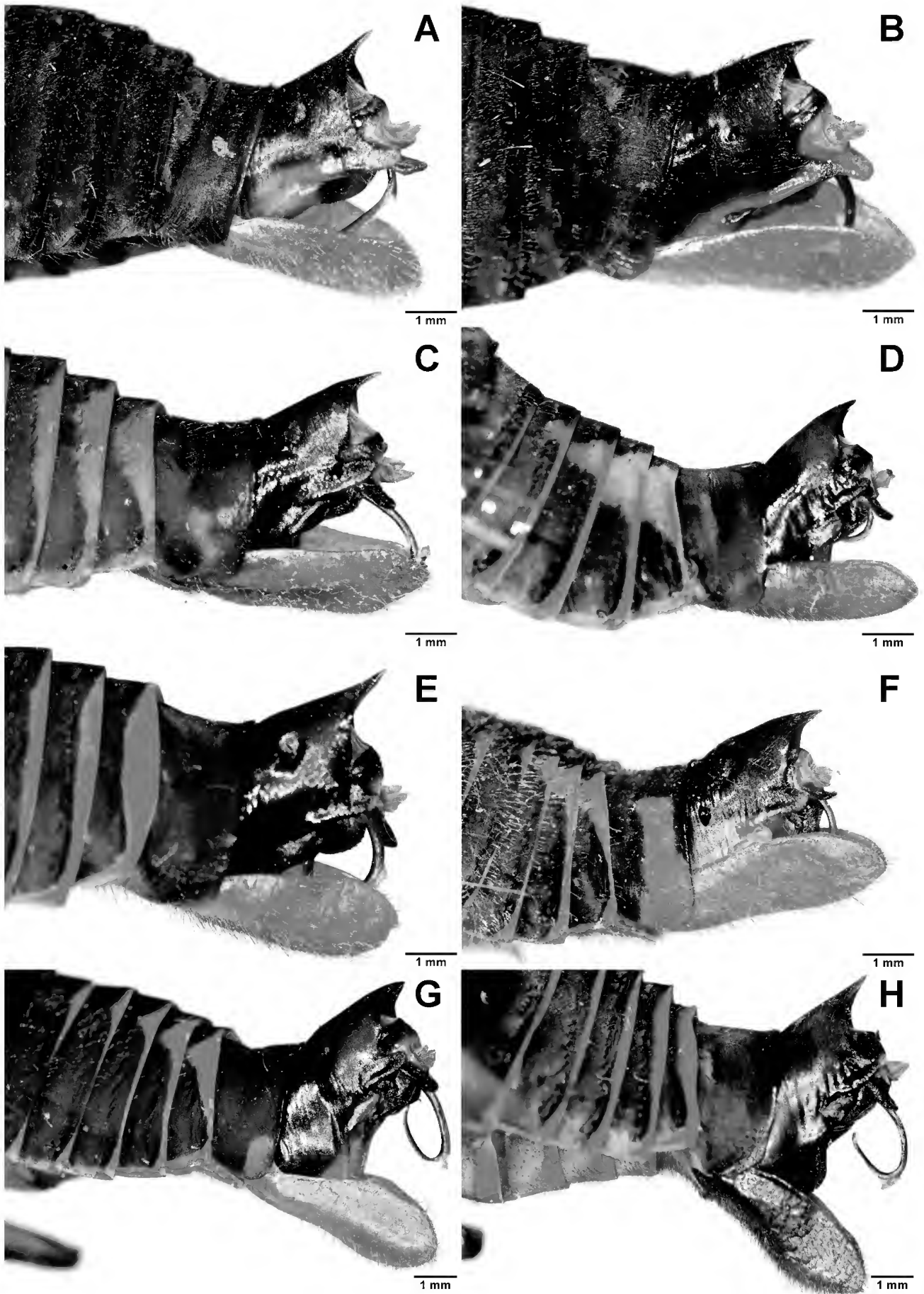
**Figure 50.** Typical male calling song structure of *Yoyetta electrica* sp. nov., illustrated in waveform plots, including (A) a bout of repeated syllables; (B) expanded section (from A) showing a single phrase with an echeme followed by a macrosyllable. The final subfigure (C) is a spectrogram displaying song frequency. The lower plot is expanded from the one above, to illustrate finer temporal structure. The spectrogram at the bottom of the figure displays song frequency. The specimen was recorded in captivity at Arrawarra (30°02'S 153°11'E) by LWP using RS2 (see *Methods and terminology*).



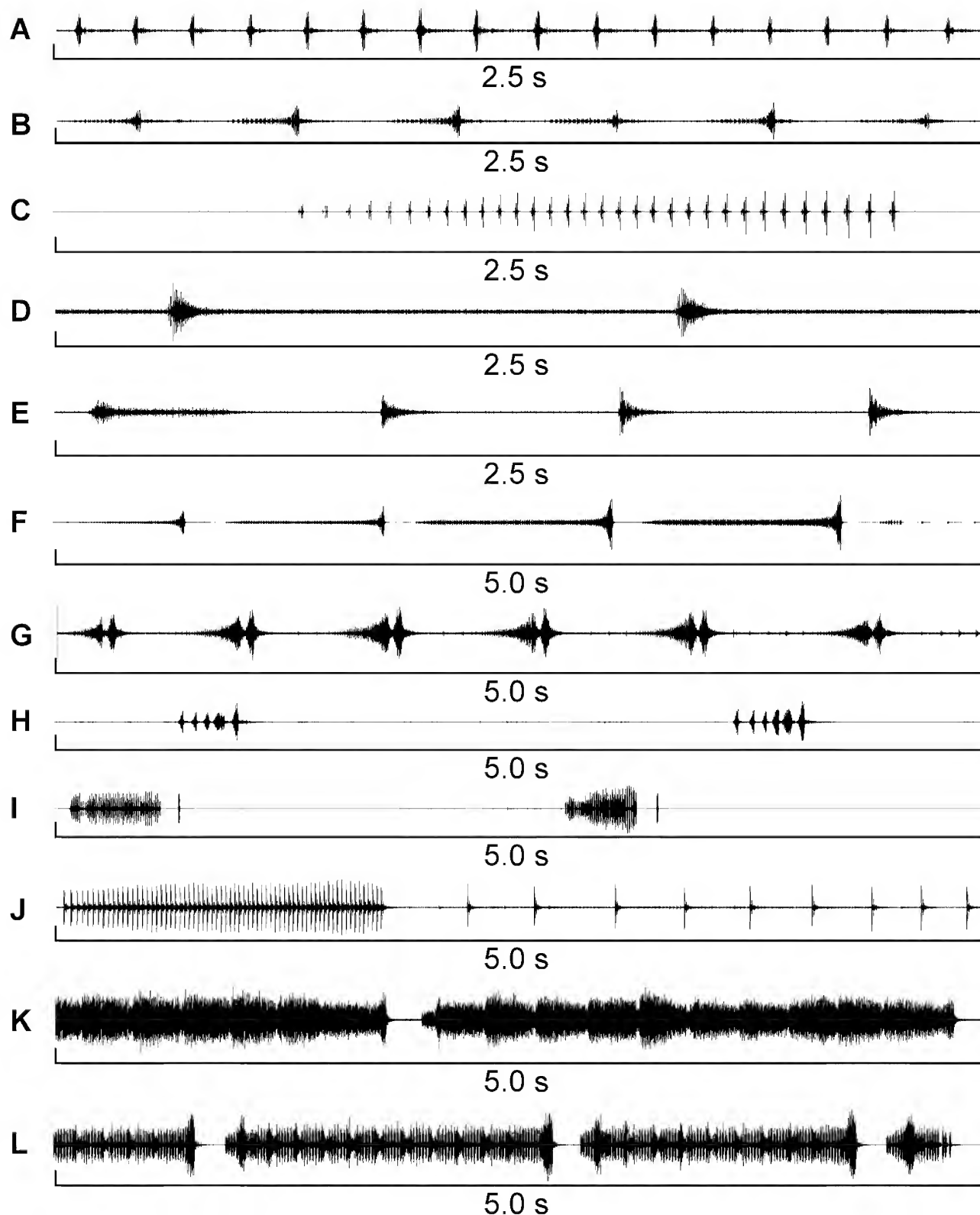
**Figure 51.** Typical male calling song structure of *Yoyetta hunterorum*, illustrated in waveform plots, including (A) a bout of repeated syllables; (B) expanded section (from A) showing a single phrase with an echeme followed by a macrosyllable. The final subfigure (C) is a spectrogram displaying song frequency. The lower plot is expanded from the one above, to illustrate finer temporal structure. The spectrogram at the bottom of the figure displays song frequency. The specimen was recorded in the field at Garie Beach (34°11'S 151°04'E) by B. Smith using RS5 (see *Methods and terminology*).

**Figure 52** [see facing page, p. 343]. Lateral views of the caudal abdomen of several males from the *Yoyetta abdominalis* species group depicted in preceding figures, including: (A) *Yoyetta timothyi* sp. nov., Gordon (33°76'S 152°15'E); (B) *Yoyetta denisoni* (Distant), O'Connor (35°16'S 145°06'E); (C) *Yoyetta regalis* sp. nov., Blackheath (33°35'S 150°50'E); (D) *Yoyetta spectabilis* sp. nov., Barren Grounds (34°41'S 150°44'E); (E) *Yoyetta subalpina* sp. nov., Cooma (36°20'S 148°14'E); (F) *Yoyetta abdominalis* (Distant), Hobart (42°52'S 147°19'E); (G) *Yoyetta serrata* sp. nov., Nimmitabel (36°31'S 149°14'E); (H) *Yoyetta grandis* sp. nov., Forrest (38°31'S 143°43'E). Scale bars = 1 mm as indicated.





**Figure 52.** [See caption on facing page, p. 342].



**Figure 53.** A comparative sample of wave plots illustrating the temporal song structure of cicadas in the *Yoyetta abdominalis* (Distant) species group (for species where song recordings were available). These include (A) *Y. denisoni* (Distant), recorded in the field at Canberra (35°16'S 149°07'E) by LWP using RS2; (B) *Y. timothyi* sp. nov., recorded in the field at Glen Elgin (29°39'S 152°03'E) by LWP using RS3; (C) *Y. electrica* sp. nov., recorded in captivity at Arrawarra (30°02'S 153°11'E) by LWP using RS2; (D) *Y. hunterorum* (Moulds), recorded in the field at Garie Beach (34°11'S 151°04'E) by B. Smith using RS5; (E) *Y. grandis* sp. nov., recorded in the field at Brindabella Range (35°20'S 148°50'E) by LWP using RS2; (F) *Y. verrens* sp. nov., recorded in captivity at Torrington (25°15'S 151°44'E) by LWP using RS3; (G) *Y. subalpina* sp. nov., recorded in the field at Talleganda (35°37'S 149°30'E) by LWP using RS2; (H) *Y. aeede* (Walker), specimen captured in Adelaide (34°56'S 138°39'E) and recorded in captivity by NJE using RS6; (I) *Y. abdominalis*, recorded in the field at Nimmitabel (36°31'S 149°14'E) by LWP using RS2; (J) *Y. serrata* sp. nov., recorded in the field at Brown Mountain (36°36'S 149°23'E) by LWP using RS2; (K) *Y. spectabilis* sp. nov., recorded in the field at Kanangra Boyd National Park (33°53'S 150°03'E) by LWP using RS2; and (L) *Y. regalis* sp. nov., recorded at Wises Track, Audley (34°08'S 151°03'E) by LWP using RS1. An explanation of recording systems (RS1–6) is provided in *Methods and terminology*.

**Material examined.** NEW SOUTH WALES: 3♂♂, Durras Nth NSW, i.1965, on high water line, I. Cameron; 1♂, Jenolan Caves, 30.xii.1991, R. Eastwood (ANIC); 2♀♀, Kanangra Boyd National Park, NSW, 33°59'18"S 150°02'25"E, 8.i.2010, D. Emery & L. Popple; 1♀, Blackheath, NSW, 33°36'05"S 150°20'00"E, 1050m, 16.xii.2012, N. & D. Emery; 3♂♂ 1♀, Rose St., Bowral, NSW, 34°28'34"S 150°25'30"E, 700m, 18.xii.13, L. Nolan; 1♀, Bundanoon, NSW, 650m, 24.xi.2017, A. Hyam (DE); 1♂, Fitzroy Falls, NSW, 15.i.54 (HEM2052, A. N. Burns collection) (MMV); AUSTRALIAN CAPITAL TERRITORY: 2♂♂ 1♀, (*in copulo*), Canberra region, ACT, xi.1997, J. Walker (DE). VICTORIA: 1♀, Gelantipy, Vic, 37°13'S 148°16'E, 29.xii.1958 (HEM2305); 1♀, Belgrave, Vic, 37°54'S 145°21'E, 24.xii.1951 (HEM2318); 2♂♂ 2♀♀, Country Fire Authority Station, Toolangi, 37°32'32"S 145°28'29"E, 27.xii.2018, S. Emery & T. Corbin (at light; HEM5761–2 [♀], 5763–4 [♂]) (MMV); 22♂♂ 3♀♀, Country Fire Authority Station, Toolangi, 37°32'32"S 145°28'29"E, 11.i.2017, S. Emery & T. Corbin (at light); 2♂♂, same location, 27.xii.2018, S. Emery & T. Corbin (at light); 4♀♀, Emerald, 37°56'50"S 145°28'13"E, 9.i.2017, T. von Strokirch; 3♂♂ 2♀♀, McMahon's Creek Rd, 37°42'05"S 145°50'06"E, 25.i.2017, N., C. & D. Emery (DE).

**Calling song** (Fig. 51, 53D). The call structure of *Y. hunterorum* comprises a simple repetitive series of macrosyllables. Macrosyllables generally range from around 63–120 ms duration ( $n = 1$ ). The phrase repetition rate is fairly consistent for the call, ranging from around 1.1–1.3 s duration. The highest amplitude frequency plateau from the single recording ranged from 9.5 and 11 kHz with a dominant frequency around 10.1 kHz (Fig. 51C).

## Discussion

Each species within the *Y. abdominalis*/*Y. denisoni* group shares a characteristic morphological feature in the distinctive, predominantly white opaque area of the hind-wing plaga. For most species, differences in the colour markings of the lateral abdomen are a readily accessible and useful distinguishing feature (Fig. 52). Field observations and recordings demonstrate that songs range from simple repeated macrosyllables or echemes ("clicking") to more complex combinations of (macrosyllables) and echemes, sometimes with patterns of amplitude modulation to create "swirling", "cascading" or "ratcheting" songs. While songs have yet to be recorded for *Y. kershawi*, males from each species, excepting *Y. spectabilis* sp. nov. and *Y. aaede*, produce songs at rest and in flight. However, the extent to which songs are produced in flight differs between species. In-flight songs are designed to elicit wing flicks from sedentary females to indicate their proximity for mate localization. As for other species in the Cicadettinae (see Hill

and Marshall, 2012; Popple and Marshall, 2016), the mating system can be exploited by using appropriately-timed, simulated finger snaps or tongue-clicks to attract males.

An overview of calling songs produced by species in the *Y. abdominalis* group is presented in Fig. 53. Four of the species (*Y. denisoni*, *Y. timothyi* sp. nov., *Y. electrica* sp. nov. and *Y. hunterorum*) produce sharp chirping songs predominantly in flight (Figs 53A–D). While the song of *Y. kershawi* stat. rev., comb. nov. has not yet been recorded, given its morphological similarities it is considered likely that this species has a similar calling behaviour to *Y. denisoni* and *Y. timothyi* sp. nov. given how similar *Y. kershawi* stat. rev., comb. nov. is in appearance to these species (confirmed by S & T. Corbin, *pers. comm.* from Kallista, Vic.). Two species, *Y. grandis* sp. nov. and *Y. verrens* sp. nov. spend a similar amount of time calling whilst stationary and in flight. The former produces sharp macrosyllables or short echemes (Fig. 53E), while the latter produces mainly long, sweeping echemes interspersed with soft ticking (Fig. 53F). The calling song structure of *Y. subalpina* sp. nov. is produced almost exclusively while stationary, but otherwise its song structure is broadly similar to *Y. verrens* (with soft ticking and accented echemes; Fig. 53G). Another stationary singer is *Y. aaede* (Fig. 53H). Yet, apart from a superficial similarity in appearance to *Y. grandis* sp. nov., it does not seem to have any close relatives in the group based on calling song or morphology.

Three species in the group, *Y. abdominalis*, *Y. serrata* sp. nov. and *Y. spectabilis* sp. nov. show obvious morphological affinities in the triangular lateral markings on the sternites (Fig. 52D,F,G). These species all call mainly while stationary, but will continue their song when flying between singing stations. The former two species have simple repetitive songs, with each phrase containing a long echeme followed by one or more (macro)syllables (Fig. 53I,J). In contrast, *Y. spectabilis* sp. nov. produces conspicuous amplitude modulations (Fig. 53K), a feature that it shares with another species, *Y. regalis* sp. nov. (Fig. 53L), with which it often co-occurs. While these two species easily distinguished morphologically, the obvious similarity in song structure suggests that they may share a closer relationship to one another than *Y. abdominalis* or *Y. serrata* sp. nov. It would be interesting to further explore relationships within the *Y. abdominalis* species group, and more broadly, the genus *Yoyetta* in general, using molecular data.

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